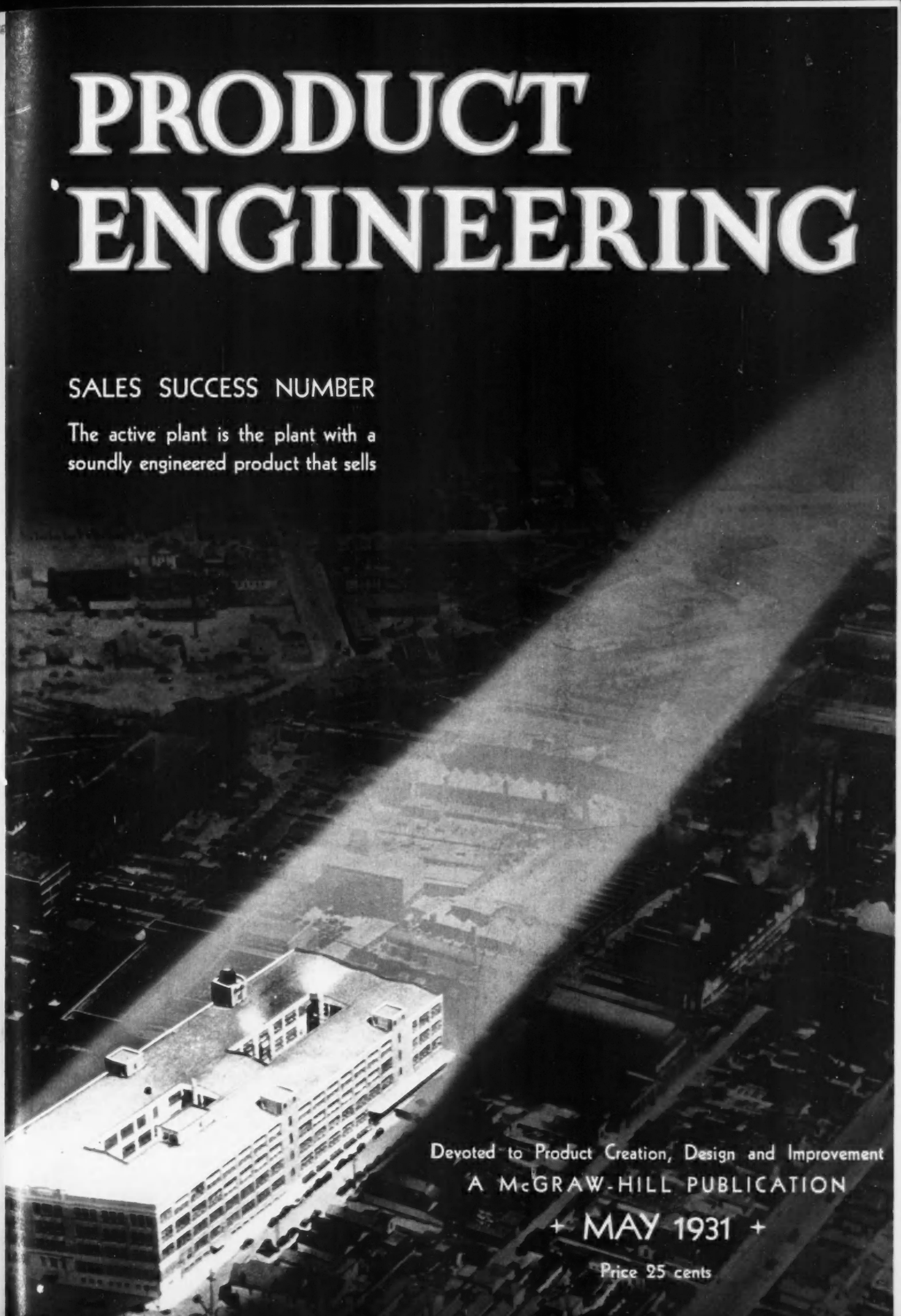
PRODUCT ENGINEERING

SALES SUCCESS NUMBER

The active plant is the plant with a soundly engineered product that sells



Devoted to Product Creation, Design and Improvement

A McGRAW-HILL PUBLICATION

+ MAY 1931 +

Price 25 cents

THE JOHNSON FRICTION CLUTCH

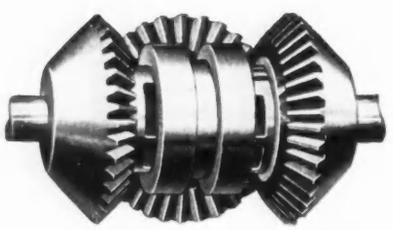
USE The NEW

SUPER-JOHNSON CLUTCH

ON DRIVES WHERE THERE IS

EXCESSIVE SLIPPING

REQUIRED OF THE CLUTCH

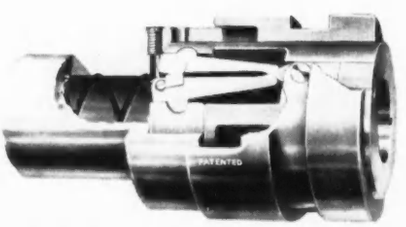


Double Clutch Between Bevel Gears

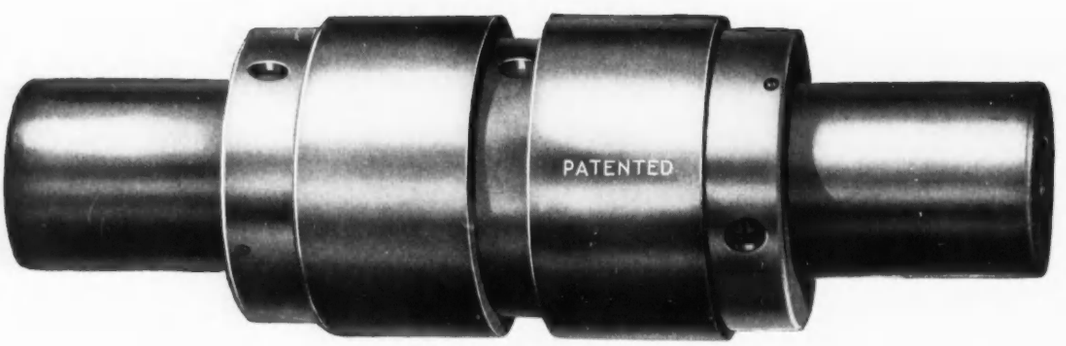
Rapid wear is the result of excessive slipping. On some drives a clutch that will slip excessively in picking up the load is required; in other cases the clutch is adjusted to slip, when a certain overload is encountered in order to prevent damage to the machine or product being manufactured. Most clutches burn out or score the frictions under such service. On the SUPER-JOHNSON a special facing which has heat resisting properties reduces wear on the friction ring to the minimum, and wear or scoring of the clutch friction cup is practically eliminated in the new SUPER-JOHNSON CLUTCH. The wear is practically confined to this special facing, and the friction ring can be easily and quickly replaced if necessary.

The life and service of this SUPER-CLUTCH is prolonged because it is much easier to shift and naturally there is much less strain on the other working parts when operating the clutch.

To lower plant maintenance and machinery construction costs, use this NEW SUPER-JOHNSON CLUTCH. It gives better service over a longer period of working time with less upkeep expense—IT IS WELL WORTH INVESTIGATING FOR YOUR COMPANY.



Single Clutch Showing Working Parts



Double Clutch, Exterior

WRITE FOR CATALOG "PE-5"

THE CARLYLE JOHNSON MACHINE CO. MANCHESTER CONN

PRODUCT ENGINEERING

Devoted to the Interests of Engineers and Executives Responsible for Product Creation, Design and Improvement

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▸ WHAT WORLD-VISIONED MINDS ◂
▸ THINK ABOUT THE WORK OF ◂
▸ THE PRODUCT ENGINEERS ◂

In What Respects is the MACHINE Superior to MAN?

It is much faster. It is more accurate. It is much more reliable.
It does not have to be clothed. It requires no amusement. Can begin work the day it is finished.
What it eats costs far less per horsepower hour.
It costs less to operate—it costs less to supervise.
It can work continually; it has more endurance.
It does not spend one-third of its life learning how.
It can continue working until the day of scrapping.
It does not spend another third of its life drawing pension.
It does not have to be pampered with warmth and comfort.

Basically civilization is indebted to slavery. So far man's upward climb has largely been upon the backs of other men. Which is all the greater reason we should now strive to make machines to be the slaves of men. To hasten this emancipation is the work before the product engineers.

Responsibilities in a New Era

Engineers with technical equipment are producing the super-machine age. Both the super-machine and the super-man must operate for the benefit, not of the smallest group, but of the largest possible group. Machines operated under best methods will displace men, the workers, only to give them fuller lives when society realizes its opportunity. The readjustment of the worker to the new conditions is one of the great questions before the world. Come the change must, and to the betterment of every one. Always progress forward has been also upward. Let the product engineers give their best, for in their work society will find *not* complication of the problem, but part of the solution.

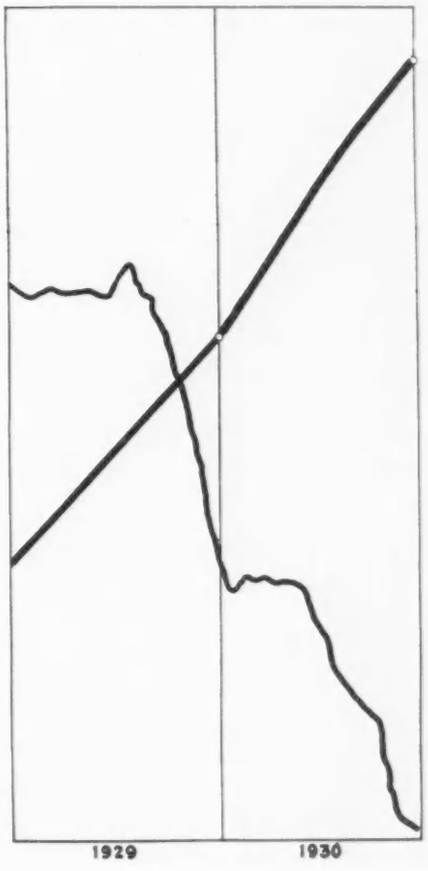
Harrington Emerson

A McGraw-Hill Publication MAY Volume Two, Number Five
PRODUCT ENGINEERING
1931

1930 Sales Successes

Built on Product Engineering

LABOR lay-offs, salary slashes, and dividend decreases have unfortunately been so common during the past year that the man in the street has come to accept them as inevitable. But are they? The graph at the right shows the descending curve of general trade and contrasted with it the upward trending sales curve of a group of electrical appliances that have been subjected to intensive and intelligent product engineering. The washing machine, subject of the first article this month, is an outstanding example.

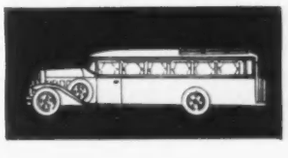


BUT we are all familiar with the efforts of engineers and designers to add sales appeal to consumer products that must compete for the customer's favor on the shelves of a store or in its show windows. It is not so surprising to discover that unusually able product engineering of such products has been able to turn their sales curves upward, and contrary to the general trade curve. What about products that go to industry?

By combining three machines into one and solving the intricate problem of securing synchronization, textile machinery manufacturers have maintained sales volume during 1930 at a level which they consider "satisfactory." The one-process picker, as developed by two manufacturers, is the sales success chosen for the second article.

IN the transportation field good product engineering has been equally successful in bringing business to companies the executives of which have had the vision to recognize the need for it, and the courage to authorize the expenditures involved. A motor bus that has been easy to sell when money was tight is the subject of the third article.

Many other sales successes built on good product engineering were considered by the editors before these selections were made. The products chosen should be looked upon as typical of the work of modern product development, not as isolated examples of accidental achievement. They should give inspiration to all product engineers, and should provide valuable ammunition to those members of the profession who must fight for recognition by the administrative heads of their organizations.



Appreciation of engineering values, effective organization for product development, and intelligent use of the engineering data in sales made 1930 a banner year for this company

DEMONSTRABLE FEATURES ✦ Not Mere Refinements ✦ MAKE SALES

By P. EDUARD GELDHOF
Chief Engineer,
Syracuse Washing Machine Corporation

THE best possible sales organization cannot market a product inferior in performance and appearance. A fundamental selling objective is to have something better and different. The sales organization, except at very heavy expense, cannot market in volume and at a profit a product with no points of superiority. It is, therefore, up to the sales and engineering organizations to learn what is required and expected by the customer, and by intelligent co-operation to provide, through the designing organizations, such a product.

An industry in which all products had been fairly well standardized was that of washing machines. Within the past five or six years manufacturers of this class of machine gradually came to produce wringer-agitator washers all just about the same in appearance, performance, and intrinsic value. Except in infinitely small particulars, no "standardized" washer delivered to the user enough more in better, easier, or faster washing to justify any apreciable difference in price, nor did any furnish new sales arguments. All had tubs, agitators, transmissions, motors, and wringers nearly alike, were mounted on four legs, and wringers were driven by means of a shaft running through a tube at the side. Absence of design features meant that the sales departments had to hang their arguments on slight differences

in materials or finishes, or upon price cuts. The result of this gradual and perhaps unconscious standardization in design was a constant lowering in retail price with consequent lowered profit.

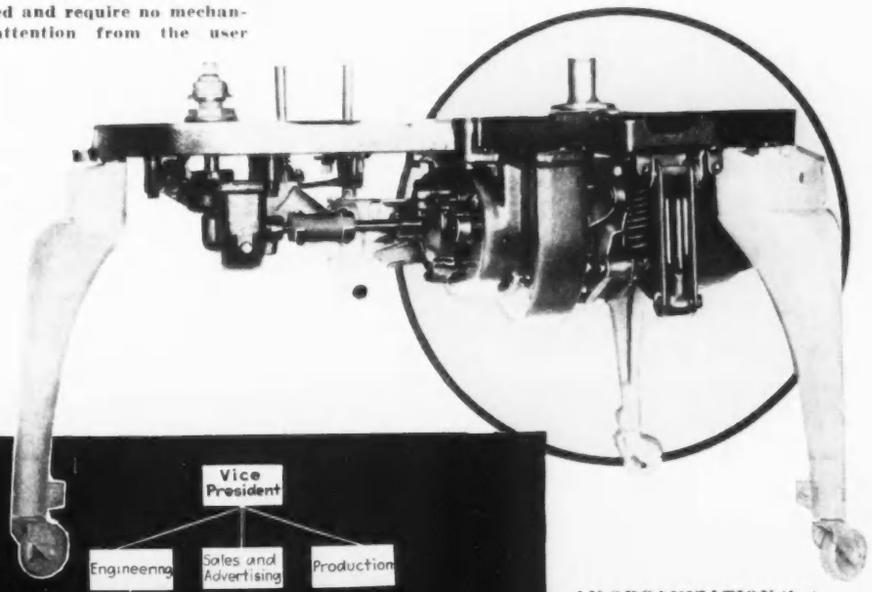
At the plant of the Syracuse Washing Machine Company, the engineering, sales, and production departments have been organized to obtain that co-ordination necessary to produce a product with outstanding salable features. As far back as 1920 the management had the engineering department begin development work on a washer using the principle of centrifugal force for the extraction of water. After six years of study and development the first "Easy" washer with a centrifugal water extractor was placed on the market.

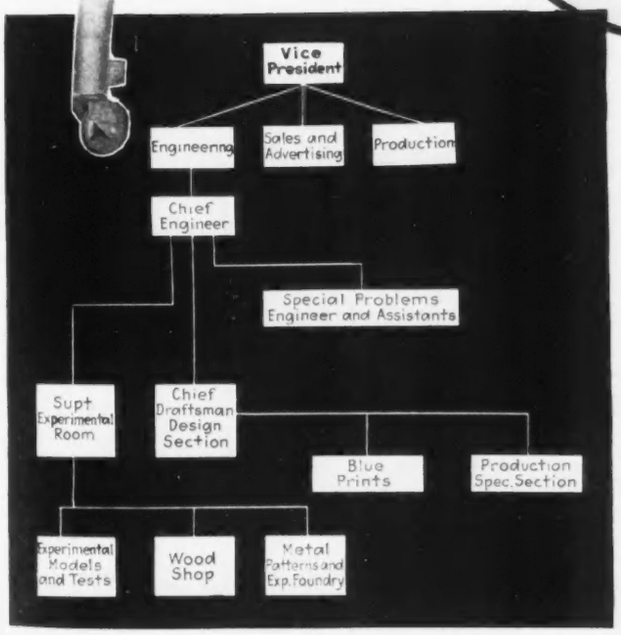
The effect of engineering and design upon sales of these washers cannot be demonstrated in one single model, however, because it affects the entire line. Co-operation between sales and engineering, with consequent close observation of the market, led to concentration on four models. First, it was determined to retain a low-priced wringer-agitator washer (the staple article of the industry), competitive in price and performance with other conventional wringer-agitator washers, but in which intelligent engineering and design would make possible a really high-quality machine at a low price.

The second step was a washer of somewhat higher price ($119.50 at this time) secured by the introduction of features which actually could be demonstrated to the customer in terms of faster, easier, and better washing, not simply in obscure, undemonstrable refinements. The main point of mechanical superiority of this model is the vacuum cup washing principle, a development of the funnel-on-a-stick invented in 1877, but several important problems had to be solved before it could be incorporated in a power washer.

The final step was the development of a machine for those customers who would pay a higher price for demonstrable points of superiority. This model, made to market at $165, is sold on the basis of greater efficiency of the centrifugal dryer over the old-fashioned wringer. The standard model incorporates the washer principle of the vacuum cups, but is also furnished with an agitator for those who prefer this type, thus bringing the number of models to four.

COMPACTNESS is a feature of the mechanism. All parts are inclosed and require no mechanical attention from the user





AN ORGANIZATION that works closely with sales and shop in product development

Before describing the mechanical features of the vacuum cup, centrifugal-dryer model, the development procedure may well be noted, because the same methods are used for each design regardless of price. All mechanical development comes under the chief engineer, but at every stage of the layout and design work, where conditions are encountered that might affect sales (either in appearance or mechanical features) contact is made with the sales department. An experimental model is then built and put into test, at which point a consulting industrial sculptor is called in. The artist-sculptor may suggest changes in machine form difficult to obtain mechanically, and for this reason he works closely with the designing engineers. For economy of manufacture, the engineer must also employ as many parts as pos-

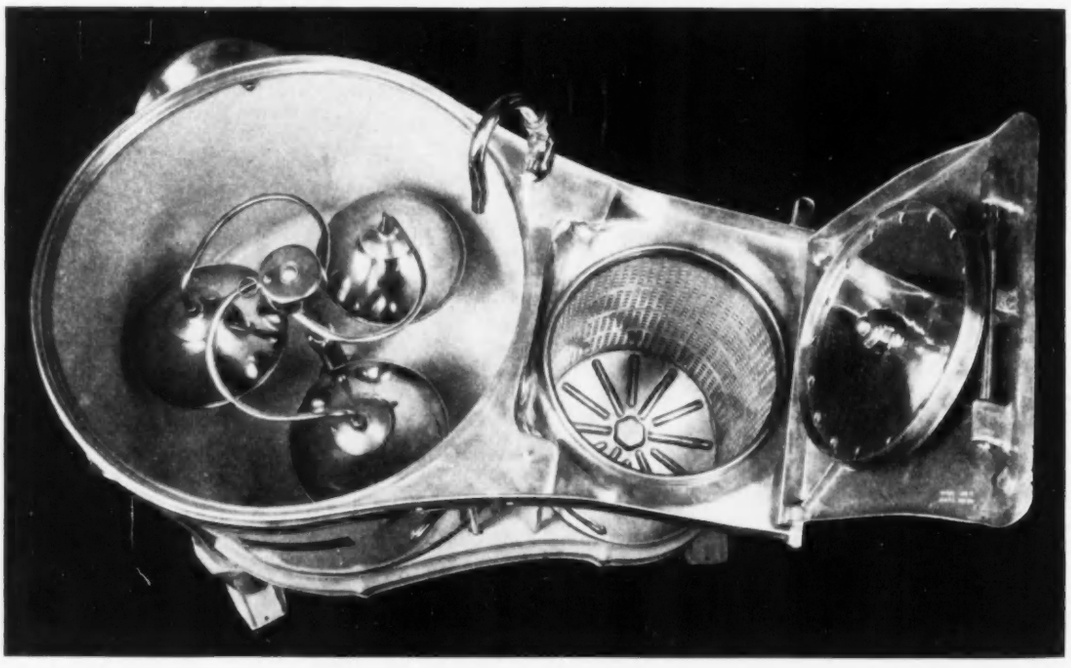
sible interchangeably in the four models. In this connection it should be noted that the same rigid requirements of parts manufacture are required in the low-priced model as in the high-priced one. The engineering department in its designs is bound by a maxim set up by the sales department —"There is nothing to hide anywhere in 'Easy' construction. Every part will stand the scrutiny of any judge of mechanical principles and performance." The program, therefore, also required that the advice and co-operation of the production executives be obtained in every important step.

Sales knowledge has been a dominant factor in the development of the Easy washer, but thorough engineering was also a necessary and vital requirement. Real engineering meant not only a layout of mechanisms to accomplish the mechanical end desired, but also the balancing of such economic features as materials, finishes, appearance, wear, corrosion resistance, and electrolytic action, in order to put into the design materials and parts that would give the best results most economically. It required knowledge of what is available in many kinds of materials and units, and vision of what happens to the machine from its contact with many varieties of water, soap, and washing compounds. Sales analysis, on the other hand, meant a study of the human factors involved.

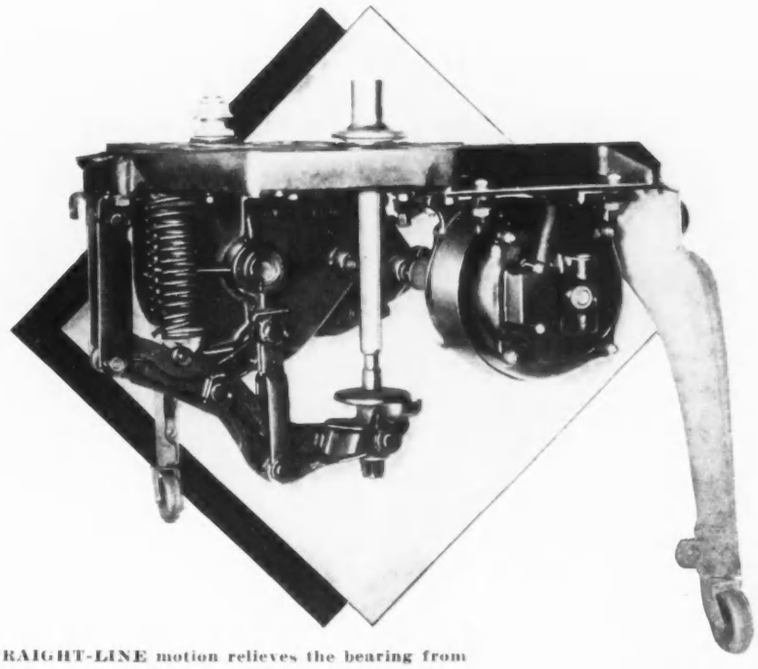
A cross-section of the drive mechanism of the highest-priced machine with vacuum principle and centrifugal dryer shows clearly the operating principles. The mechanism is attached to the underside of a cast-iron base and consists of the motor, direct connected to the transmission reduction unit, straight-line lever system, pump, and dryer gear unit. Transmission cases are of gray cast iron. A ¼-hp. motor drives the main shaft. A Textoil pinion on the motor shaft, operating at 1,725 r.p.m., drives a cast-iron gear, and the second reduction pinion is steel against a cast-iron gear. This last drive gear operates at 66 r.p.m. Uniform wear and minimum friction are absolutely necessary if the machine is to remain silent indefinitely, so the pinion and gear are designed with the motor-shaft pinion making 79 revolutions before the same teeth come into mesh again, thus distributing wear. The gear train runs in a bath of oil, thus requiring no attention after installation.

Another point of noise elimination is in the clutch application to the gear train. There are 102 teeth in the driving gear, but only about 50 teeth do the driving during any one period of washing. This condition would wear the gear unevenly, and hence eventually would make the train noisy. The clutch, therefore, will engage in four positions so that, by the law of averages, gear engagement will be distributed over all teeth over a length of time. Tests of continuous running for a period of six months, as much work as would be required of the machine for a whole lifetime of ordinary washing, have resulted in no serious wear.

In the transmission unit is incorporated the cone-type clutch, operating on the intermediate gear which drives the dryer basket. This clutch



APPEARANCE and cleanliness were stressed in the design. The aluminum die casting in the top structure was made after the sculptor's design. It weighs 6.5 lb., has high tensile strength, and is easily polished to a blue luster finish. Tubs are porcelain enamel inside and outside. The stream line base hiding the machinery, and the legs, are finished in gray Duco



STRAIGHT-LINE motion relieves the bearing from excessive wear and prevents leakage. All working units of the washer are permanently secured to the cast-iron base

is cast iron to cast iron, operating in a bath of oil, which permits slippage at first, allowing the motor to pick up the load of heavy wet clothes without overloading, as the oil is squeezed from the cone surfaces by the heavy spiral clutch spring. The clutch is full floating and requires no ball thrust bearing.

When the clutch is thrown out, a brake is applied automatically. The brake is lined with standard automobile brake lining, either Rusco or Raybestos of sufficient working area to reduce the unit pressure to about 10 lb. per sq.in. This brake will last the entire life of the machine. The take-off drive from the main transmission runs at 460 r.p.m. and is stepped up through spiral bevel gears to give 860 r.p.m. to the dryer shaft. This gives about 2,250 ft. per min. peripheral speed to the dryer basket.

Both motor and dryer drives are through 7-ply flexible rubber couplings to give quiet operation and the necessary resiliency for shock loads. An Oldham type flexible coupling is located between the main transmission and the pump. The intermediate member of this coupling is hickory fiber.

The dryer differs from other centrifugal dryers in that it has both an upper and lower bearing, permitting the basket to rotate vertically between two fixed points. In this way vibration is reduced to a minimum without the use of complicated balancing devices. The upper cover of the basket rotates on a ball bearing held by a stud attached to the outer cover. This stud permits adjustment for raising and lowering the inner cover to meet various basket heights. The bearing is a Size 202 Gurney taking radial load, and an auxiliary ball is provided at the lower end of the stud for taking the thrust load. The outer cover is hinged. When in the open position it forms a drain board, but when in the closed position it seals the dryer chamber for safe operation. Under the basket and screwed into the base castings is the lower dryer bearing. This consists of two graphited bronze bearings $\frac{7}{8}$ in. in length with a space between for grease fed by a grease cup. Oil may also be fed through the top of the basket drive shaft, lubricating these bearings and the leather seal placed at the upper end of the bearing in the dryer chamber. The basket drive shaft is hardened steel with cadmium plating on the exposed end. The lower end of this shaft rests on a hardened ball entirely submerged in oil, and on this the entire basket load and downward pressure of the upper cover is taken. Thus the basket actually rotates between two ball thrusts. An important consideration at every point of the design of both the washer and dryer was the feature of thorough lubrication with minimum attention.

As a double safeguard against water leakage into the bearing and gear case, an air cup is located over the stuffing box. If a large quantity of water should flow into the dryer the air pressure in the cup would prevent the rise of water to a point where it could leak through the leather seal. The basket drive cup, a zinc-base die casting, covers the seal mounted in the top of the dryer bearing. The chrome-tanned leather seal hugs the $\frac{5}{8}$-in. drive shaft securely and is lubricated through the center of the body cadmium-plated, hardened and ground, drive shaft. The seal will last the lifetime of the machine without leakage.

The dryer basket has a heavy brass bottom for strength, perforated aluminum sides, and a seamless, heavily nickel plated, 22-oz. copper band around the top. This makes a very economical assembly in that it permits a light-weight aluminum basket only 0.028 in. thickness, but with a rigid rim of copper which will withstand chafing against the inner cover of the basket. Aluminum would cause black smudging. Balancing of the

basket is accomplished by the elimination of holes diametrically opposite the seam.

Frequencies of 25, 40, 50, and 60 cycles, used by various electric power producers, makes a problem for the washing machine designer. The various frequencies have different motor speeds, and changes must be made in the gearing so that washer and dryer maintain their proper speeds. The gearing described is for the 60-cycle motor, which takes care of 98 per cent of the requirements. However, design is always handicapped by provision for the remaining 2 per cent of odd frequencies.

The straight-line lever system for operating the vacuum cups was developed after much difficulty with the conventional system. Trouble arose in that the lower end of the piston had to have its bearing in the center post to take the side thrust. This could not be lubricated without carrying the lubricant into the washing container. The straight-line lever system was an adaptation of one well-known movement for converting rotary into straight-line motion. In the 7-in. stroke there is an error of only a few thousandths of an inch, created by permitting the opposite end of the main lever to swing in an arc. This slight error is negligible in this application. The top red-brass bearing of the piston is in the center post. Above it is a jute packing lubricated by soap suds from the washing compartment. No mineral lubricant can be used on this packing nor on the lower bearing.

The crank is an S.A.E. 1035 steel drop forging, the main lever and straight-line lever are of malleable iron, and the rear supporting lever is of pressed steel. All pins are of hardened and ground steel, operating in cast-iron bearings. The entire system is lubricated from a single point in the rear. Soft felt wicking holds back the oil so that it will feed slowly. No oil pipes are used, but channels are cast into the base spider on an incline which causes the oil to flow slowly.

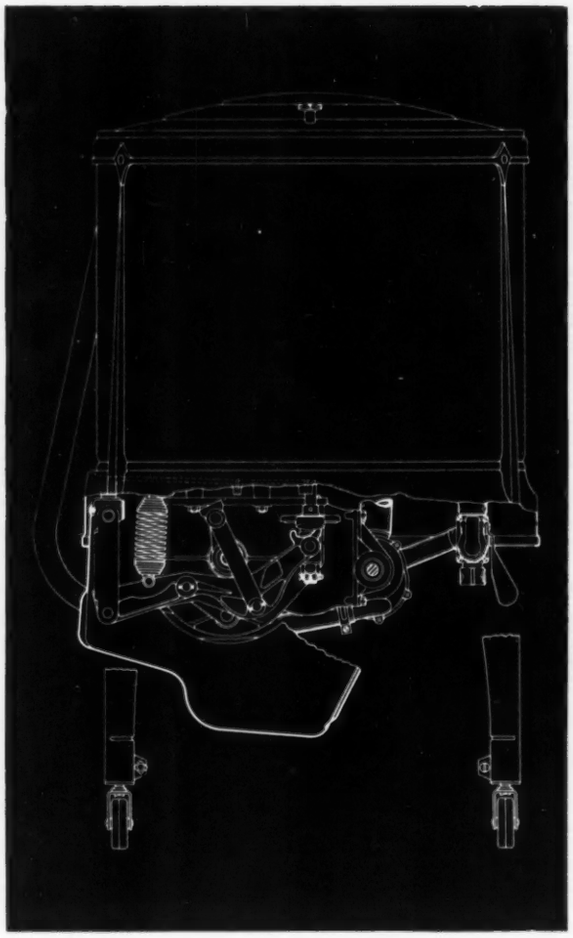
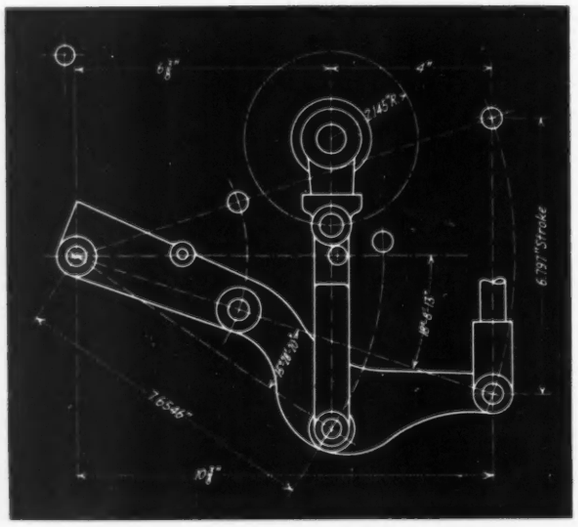
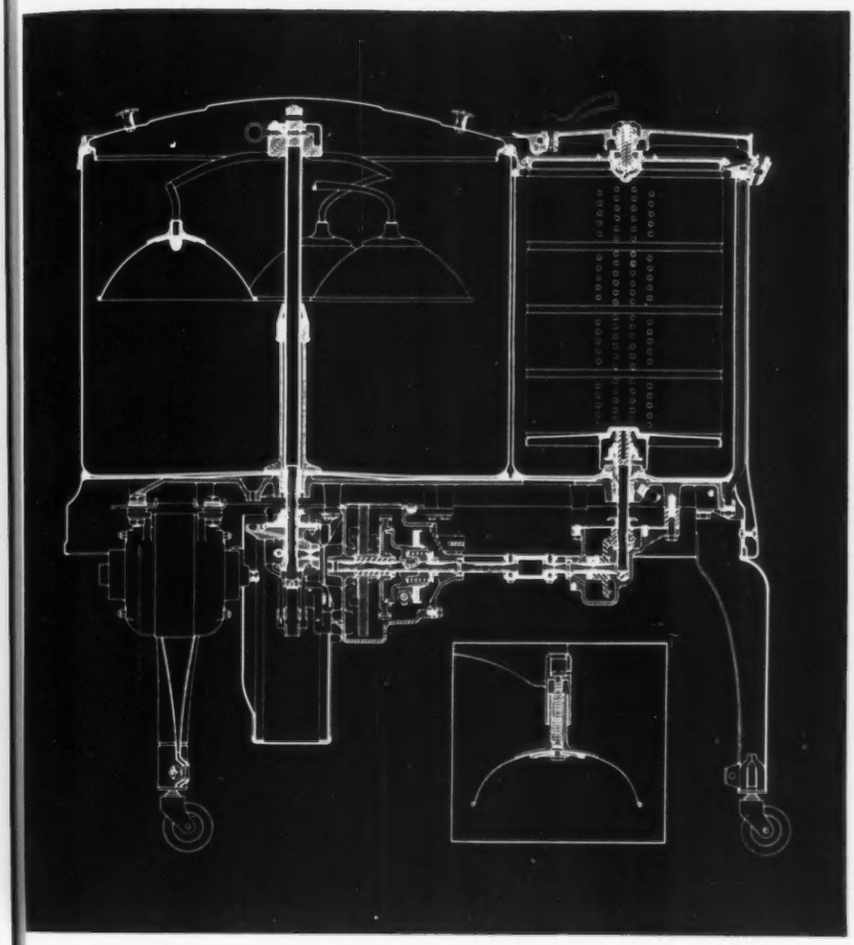


DIAGRAM of the lever system employed to secure straight-line motion in the vacuum-cup rod



Washer cups are made of heavily nickel-plated 22-oz. copper, as hard as can be drawn suitably. The spring arm assembly was adopted upon discovery of a suitable chrome-vanadium spring steel. These springs are copper, nickel, and chromium plated, making them resistant to corrosion. The spring-arm assembly gave more flexibility for overload, without the necessity of a slip coupling on the drive shaft.

The pump has been developed to handle 8 to 10 gallons of water per minute with a consumption of not over 15 watts. The main difficulty in the design of a small pump of this class is with air binding, which is overcome by the form of inlet. All water connections are by means of soft rubber hose with inserted fabric, and hose clamps are eliminated by having a bead on the part over which the rubber slips. The zinc-base die castings used are ideal for the pump parts as



Materials Used In Easy Washers

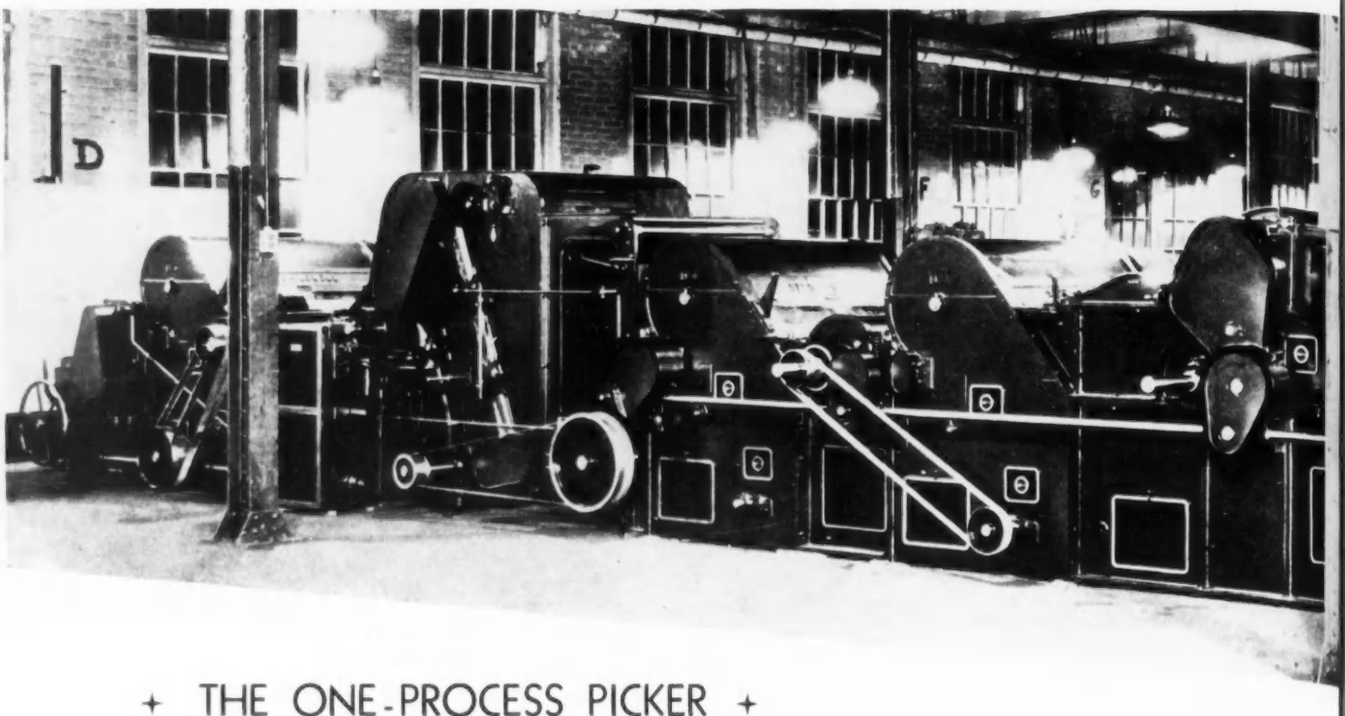
EIGHTEEN countries and six continents contributed materials for this washer. The designer of today is not satisfied with tradition. He selects, from the vast number of materials available, those that will best serve his purpose economically. He chooses commercial parts the same way.

Cast iron	Felt wicking
Malleable iron	Jute packing
Pressed steel	Chrome-tanned leather
S.A.E. 1035 steel	String graphite packing
Armco ingot iron	Raybestos brake lining
Steel forgings	Rusco brake lining
High-carbon steel	Porcelain enamel
Chrome vanadium steel	Nickel plating
Brass forgings	Cadmium plating
Cold drawn brass	Copper plating
Sheet copper	Chromium plating
Sheet aluminum	Gaskets
Aluminum forgings	Ball bearing
Aluminum sand castings	Electric motor
Aluminum die castings	Etched nameplates
Permanent mold aluminum	Lock nuts
	Cotter pins
Zinc-base die castings	Galvanized screws
Molded rubber	Hollow-head setscrews
Sheet rubber	Commercial casters
Bakelite	Decalcomania
Durex bearing metal	Textoil gears
Moraine bearing metal	Spiral springs
Graphited bronze	Safety switch
Hickory	Electric cable
Cloth	Tapered pins
Rubber and fabric hose	Washers
Waterproof grease	Casters

they give light-weight, smooth-surface castings that require no machining. They are cadmium plated to withstand the soapy water solutions. Hardened hollow-head setscrews are used throughout the machine.

The pump shaft is hardened and ground. Non-scoring string graphite packing, held in by an adjustable nut, is arranged to be kept well saturated with oil. Impeller thrust is taken up on the back end of a Durex bearing. Upon assembly a Kasson waterproof grease is used and appears to last indefinitely. The Durex bearing can be lubricated, but this is not necessary.

Tubs are porcelain enameled on Armco ingot iron both inside and out. This arrangement is more expensive than the previous plain copper tub, but is easier to keep clean, does not dent as readily, and permits the many variations in color important in merchandising today. The washer cover is of pressed aluminum. The knobs are die cast of aluminum, and the hardware is zinc-base die casting metal, nickel and chromium plated. All hardware was designed by the sculptor. The base pan and legs are heavy pressed steel. They presented many difficulties in the securing of a design which could be made easily and still would fulfill the sculptor's ideas. The design was first carefully worked out in wood, clay, and wax. After the model was satisfactory to the sculptor, the various manufacturers of large stampings were consulted, and they, together with the sculptor, went over the difficulties. Stampings of base pan and legs resulted that would not impose any additional manufacturing cost and still fulfill the sculptor's desires. Every detail that will be exposed to view is subject to the criticism of the artist. Even such details as a nameplate that is bought outside are worked out to a preliminary design before being requisitioned on the market.



✦ THE ONE-PROCESS PICKER ✦

A Unification of Three

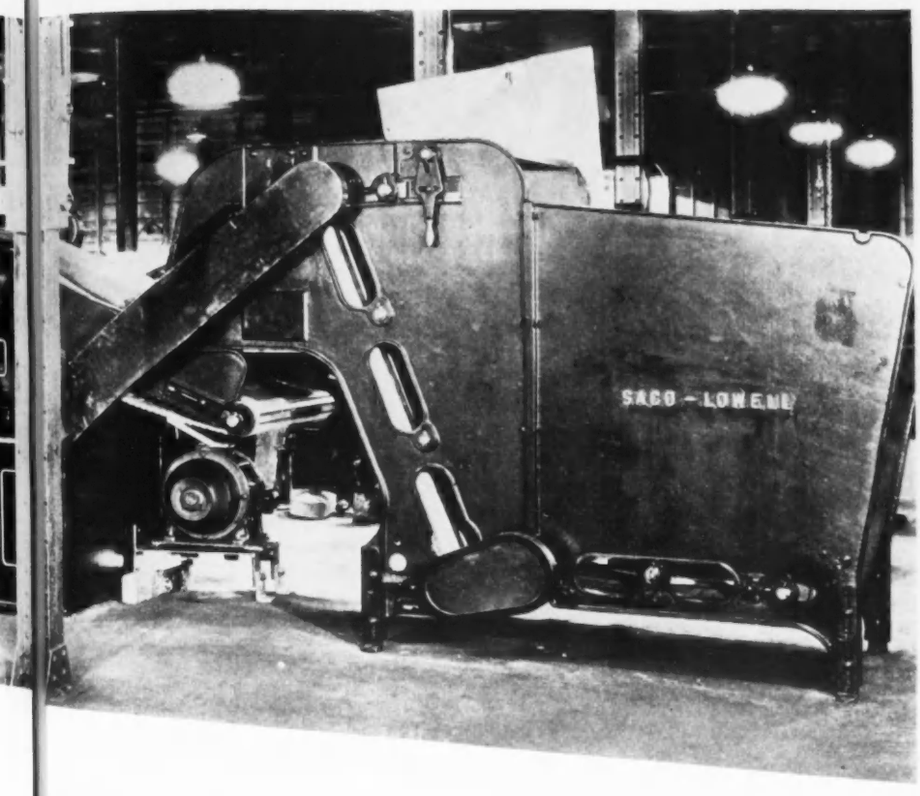
When one machine will do the operations formerly done by three separately-operated types and do a better and cheaper job, its sale is certain, depression or no depression. Design of the one-process picker required the development of automatic controls for synchronizing the units. This was no small task. Sales success has been the final reward

✦

IN THE manufacture of cotton yarn, three separately operated types of machines, called pickers or lappers, formerly were required to process cotton stock into lap form, a sheet closely resembling the familiar cotton batting. Today, the entire operation is performed by a single machine.

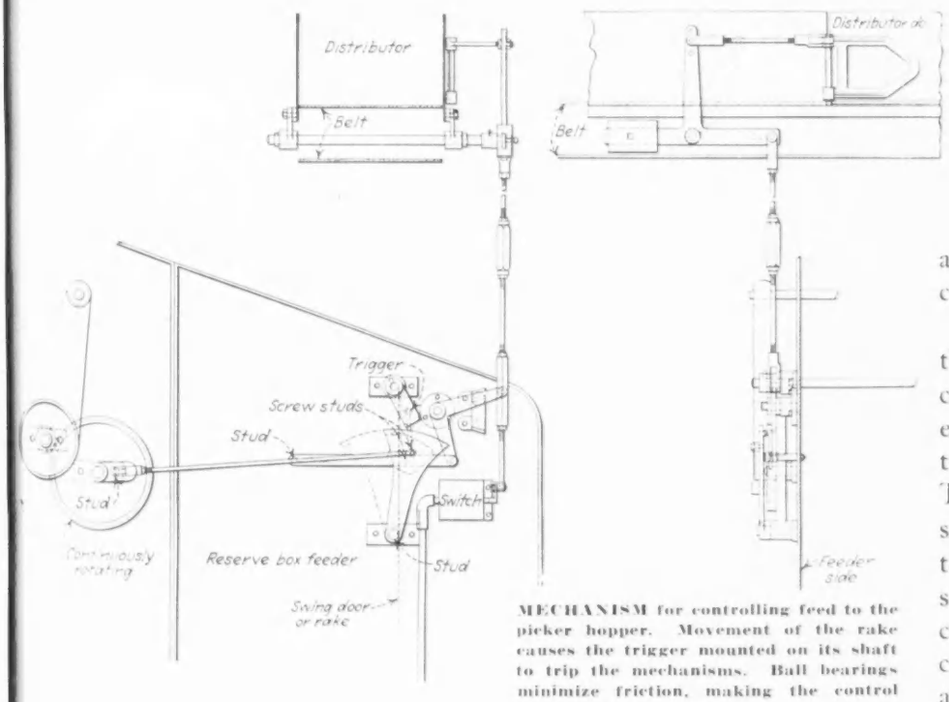
To continue the three pickers into one machine was not a simple engineering problem. It is absolutely essential that the finished lap have a definite and constant yard-for-yard weight, because any irregularities are carried through the processes, showing up as unevenness in the finished yarn. In three-process picking the uniformity in weight of lap was obtained partly by regulating carefully the feed to each of the pickers. In the one-process picker the feed to the intermediate hoppers has to be regulated automatically, and the different sections of the machine have to be driven in perfect synchronism so that an even sheet of cotton is finally delivered. This is accomplished by the use of sensitively designed feed controls as embodied in two machines here described.

Cotton from the opening and cleaning machines, which fluff the cotton and take out the bulk of the dirt, is conveyed to the feed hopper of the several one-process pickers that may be in operation. The control of the feed to each picker from the cleaners is regulated by mechanism connected to a swinging rake or door placed in the picker breaker feed hopper. The mechanism is shown in Fig. 2. The pulley and



Illustrations from Whitin Machine Works and Saco-Lowell Shops

Machines



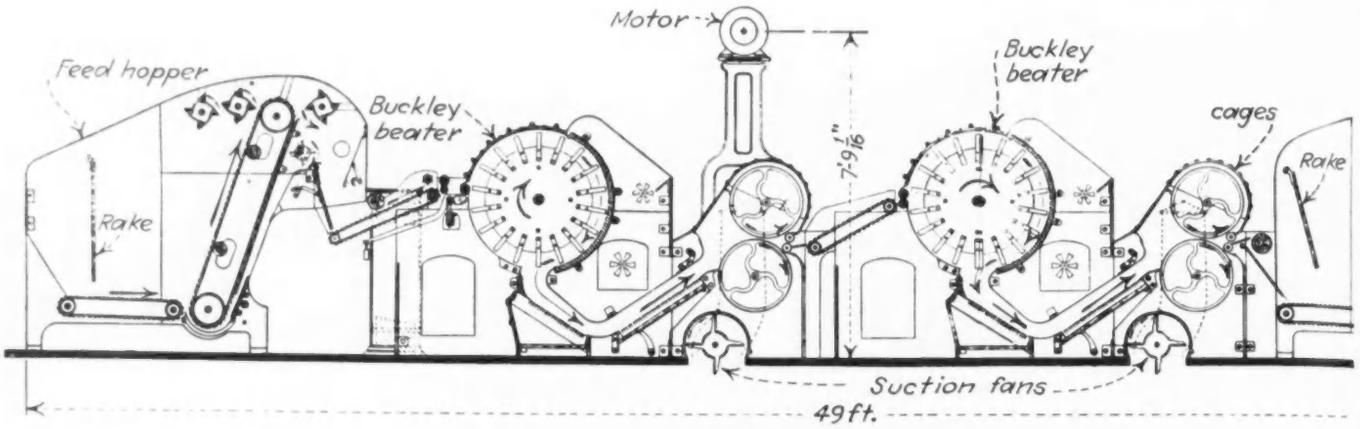
MECHANISM for controlling feed to the picker hopper. Movement of the rake causes the trigger mounted on its shaft to trip the mechanisms. Ball bearings minimize friction, making the control more sensitive

gears at the extreme left rotate continuously, driving the connecting rod attached to one of the gears. When a proper amount of cotton piles up in the picker breaker feed hopper, the swing of the rake or door causes the latch, or trigger, to throw the quadrant attached to the control bar. A lug on the quadrant will then be in the path of motion of a lug on the connecting rod, the quadrant and bar to which it is attached being thereby pushed to their extreme position, operating the switch and closing the distributor gate. When the supply of cotton in the hopper has diminished to a predetermined amount, the latch throws the quadrant in the opposite direction, and the bar is pulled back, closing the switch and opening the gate of the distributor.

The electric switch is in parallel with similar switches mounted on the breaker feed hoppers of the other pickers, and controls the motor driving the line of cleaners. When each breaker hopper contains its proper amount of cotton, all switches will be open and the cleaner unit driving motor stopped.

The horizontal feed apron in the bottom of the picked hopper consists of hardwood slats fastened with copper screws or rivets to four heavy flat leather belts. The elevating lattice feed apron is similarly constructed with the addition of extending sharp steel pins set at an angle, that are used to carry the cotton upward. Heavy canvas is placed between the slats and the belts to prevent the stock from being driven between the slats.

A chain drive conects the feeder apron and the elevating apron, because a positive drive is absolutely essential to feed uniformly. Though the pulley centers are close, gears can not be used unless an idler is interposed to get the proper direction of rotation. One of the machines in-



vestigated uses an Ewart type of chain to gain the advantage of quick detachable links. The other machine uses a roller chain.

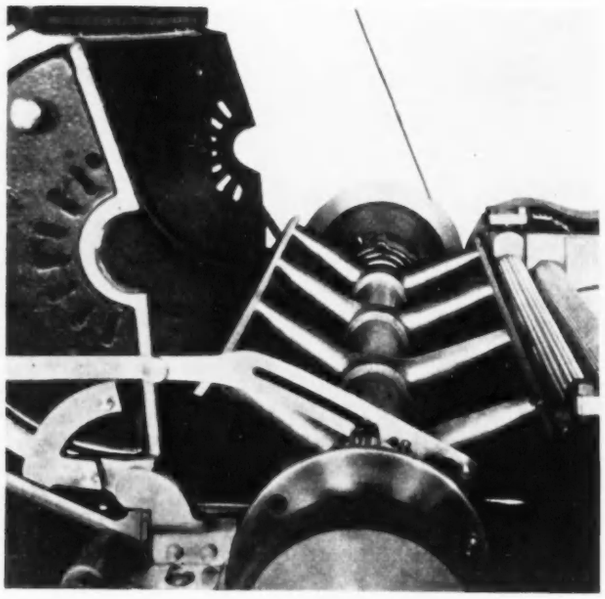
When the cotton reaches the top of the elevating feed apron, it passes under a rapidly-rotating straight-fluted wooden roller that evens out and presses down the stock. In the other machine, a spiked evener roll combs off the surplus cotton, throwing it back into the hopper. An auxiliary stripper, a roll having four leather strips, takes off any cotton that clings to the evener roll.

After passing over the head pulley of the elevating apron, the cotton is stripped off by an adjustable doffer roll. Triangular-shaped adjustable grid bars arranged below the doffer roll form the bottom of a reserve feed box and permit any dust or dirt beaten out of the cotton to fall through and into a dirt chamber below.

In the cross-section view shown, the space in the reserve feed box into which the cotton is thrown may be adjusted to feed a specified quantity of cotton to the next feed apron. Any surplus stock is caught by a stripper roll, thrown onto the underside of the elevating feed apron and thus returned to the feed hopper. The two adjustment doors for regulating the space in the reserve feed box are controlled from the outside by two indexed levers.

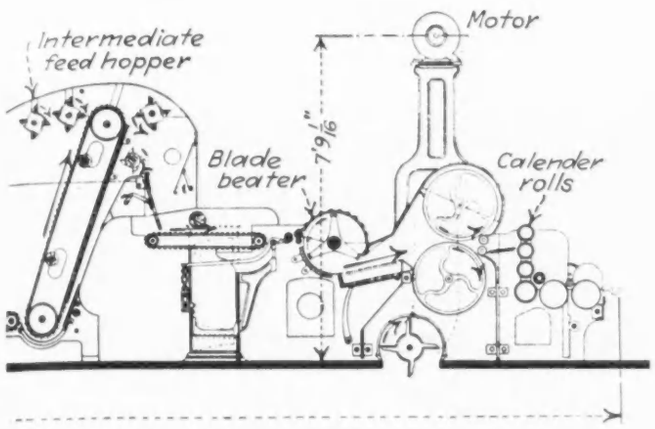
From the reserve feed box, the stock is fed by a fluted delivery roll onto an apron conveyor, passes under a presser roll, and is delivered by an enticing roll to a pair of steel-fluted feeder rolls. These feed the stock to the Buckley beater or cylinder. As a uniform even feed is of greatest importance, the delivery roll is driven by a chain from the enticing roll, which in turn is driven by the feed roll. For the same reason, the pin elevating apron in the feed hopper is also positively driven from the same source as the feed rolls.

The space between the feed rolls must vary to suit the thickness of the stock passing between them. Both rolls must rotate at exactly the same speed. Therefore, they are connected to each other by long-tooth involute spur pinions having a small number of teeth. In some cases, a double gear with staggered teeth is used. Involute profiles are used as these tooth profiles maintain a constant ratio of pitch diameters even when the center distances vary, as long as at least one pair of teeth is always in contact. To provide for variable distance between the rolls, the driving shaft is journaled in fixed bearings and the shaft of the driven roll is mounted in brass-bushed bearing boxes that slide in guides and are backed by coil springs.



BLADE BEATERS have drop-forged steel arms, stream-lined and polished to prevent air churning. The linkage in the foreground is the beater lock, which makes impossible the opening of the beater cover or the glass inspection door of the cage section when the machine is running

The Buckley cylinder or beater consists of circular steel disks having extending steel fingers riveted on, the disks being spaced by cast-iron fillers. Triangular-shaped steel grid bars sur-



CROSS SECTION of a three beater one-process picker

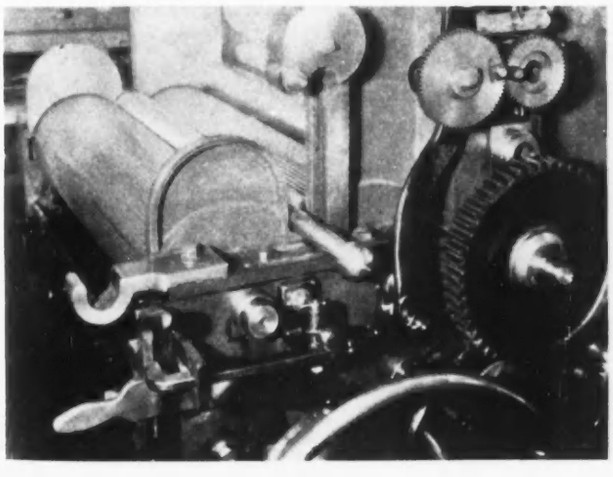
round the cylinder for the greater portion of its circumference, so that dust and dirt beaten out will fall between the bars and down into a dust chamber.

From the Buckley cylinder, the cotton passes between a pair of screens or cages. These consist of a steel screen cloth formed into a cylindrical shape, and carried on cast-iron spiders mounted on a steel shaft. The interior of each cage is connected by a duct to a suction fan which sucks dust out of the cotton.

Leather linings serve to prevent leakage of air around the ends of the cages. Similar linings are used wherever there is danger of cotton falling down along the frame sides and winding up on shafting, where it may cause fire or undue friction.

Bearings for the slowly-rotating shafts, such as those for the feed apron and screen cages, are either plain cast-iron or brass bushed. Some of the bearings are swiveled on a yoke so as to make them self-aligning, the yoke being fastened to the machine frame by means of a centrally located stud, thus enabling alignment in any direction.

WHEN the knock-off lugs on the gears come in contact, the gear mounted on the lever is thrown outward, thus operating the stop that shuts down the machine



Ball bearings are used for all high-speed rotating elements. Zerk or Alemite fittings are used for lubrication of ball bearings, and oil hole covers or oil cups are provided at all plain bearings to keep out lint and dust.

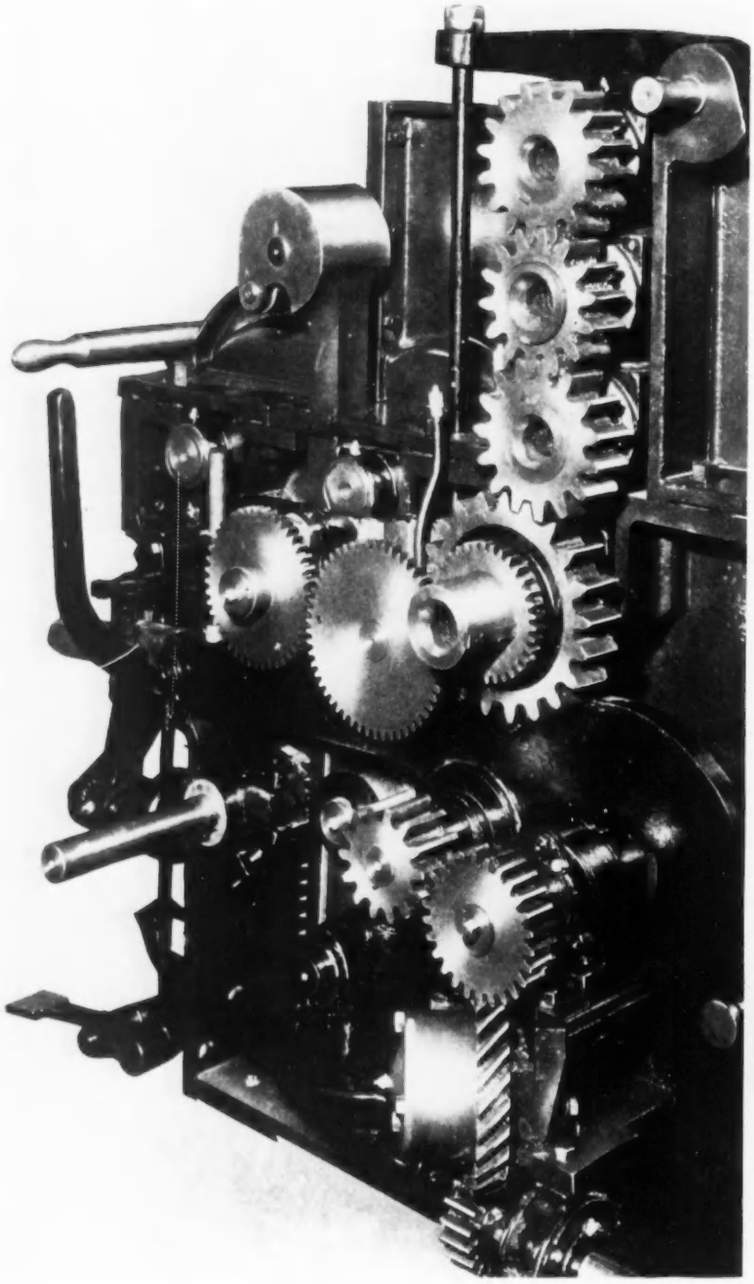
In the three-beater one-process picker, the cotton passes through a second beater and screen section similar to the first, except that the second beater may be of the blade type such as illustrated. The blades are double-edged so that they may be reversed when one edge has been dulled.

After passing through the second cage section, the cotton is stripped off the cages and delivered to the intermediate feed hopper. This hopper is provided with a rake similar to the one in the first feed hopper. By means of a bellcrank lever on the outside, the position of the rake, as determined by the amount of cotton in the hopper, controls the position of a belt between the two cone pulleys of an evener motion. The connecting linkage is made as light as possible, tubes being used in some cases instead of bars, in order to minimize inertia resistance. Ball bearings minimize friction.

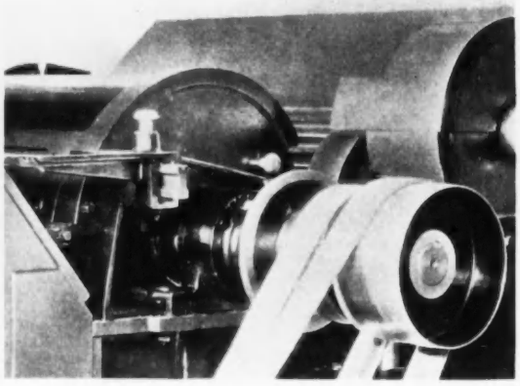
The lower cone pulley of the evener motion, as shown in the illustration, is driven by a silent chain drive from the side shaft of the picker, or is direct connected to the shaft. The lower cone drives the upper cone which, in turn, drives all the feed rolls, delivery rolls, and conveying aprons between the first and the intermediate feed hopper. Necessary speed reduction at the upper cone pulley is obtained through a worm gear reduction.

For quick action, the belt guide is placed close to the face of the cone, and the shipper bar conforms to the shape of the cone so that as the belt guide is moved across the face of the cone, it will remain at a constant distance from it. The shipper bar rolls on ball bearings in order to minimize the force required to move it. A flange on the small end of the cones prevents the belt from slipping off. The cone shafts run in ball bearings.

Just before the stock enters the feed rolls for the third beater, it passes between a pedal roll and 16 evener pedals placed directly below the pedal roll. Each pedal acts independently, rising or falling according to the thickness of the cotton passing under the pedal roll. An extending arm on each pedal is pivoted close to the pedal and a chain link is hung from its far end. The chain links are paired off successively, with the result that the average of the algebraic sum of the movements of the individual pedals is finally im-



FINISHER section showing drive for calander rolls, yardage knock-off, and drive to side shaft. One helical gear train drives the side shaft, as shown in the lower right corner, in order to get away from a multiplicity of bevel gears.



PRESSING DOWN the knob and sliding the locking bracket permits the beater cover and the glass inspection door to be opened, at the same time engaging a stud with a slot in the disk keyed to the beater shaft. To do this the machine must be stationary, and cannot be started until the covers have been locked

parted to a counterweighted arm which, in turn, through linkages, controls the evener motion. This evener motion controls all the feeds from the intermediate feed hopper to the finisher section. A turnbuckle at the evener box, not visible in the illustration, allows adjustment to regulate, as desired, the weight of the cotton passing into the last beater. Usually, this beater is of the Kirschner type, having steel pins extending from wooden bars.

When the machine is stopped, it is necessary that all of the elements driven through the evener motion, namely the pedal rolls, feed rolls, cages, and aprons, stop simultaneously. For this reason a multiple-tooth clutch is mounted on the shaft of the worm gear that is driven by the upper cone pulley of the evener motion. The clutch is engaged and disengaged when the drop lever is knocked on or off to start or stop the machine.

In passing through the calender rolls, lumps of cotton or any large foreign substance might force the rolls up and cause breakage of gears. In order to prevent this, the calender rolls are weighted down by a lever. When the calender rolls are forced up, the weighted lever engages a trip mechanism that causes the whole unit to stop.

When the predetermined length of lap has been wound on the lap roller, the yardage knock-off motion is actuated. In this mechanism, one of a pair of spur gears is mounted on a calender roll shaft and the other is mounted on a lever. Knock-off lugs are bolted to each of the gears. The numbers of teeth selected for the gears are such that the lugs will come in contact each time that the calender roll has rotated the number of times required to pass through the predetermined yardage. When the lugs make contact, the gear mounted on the lever is thrown outward, thus operating the stop that shuts down the machine.

Cast-iron gear guards cover all exposed gears and moving elements. Cast iron is used in preference to sheet steel for several reasons. The

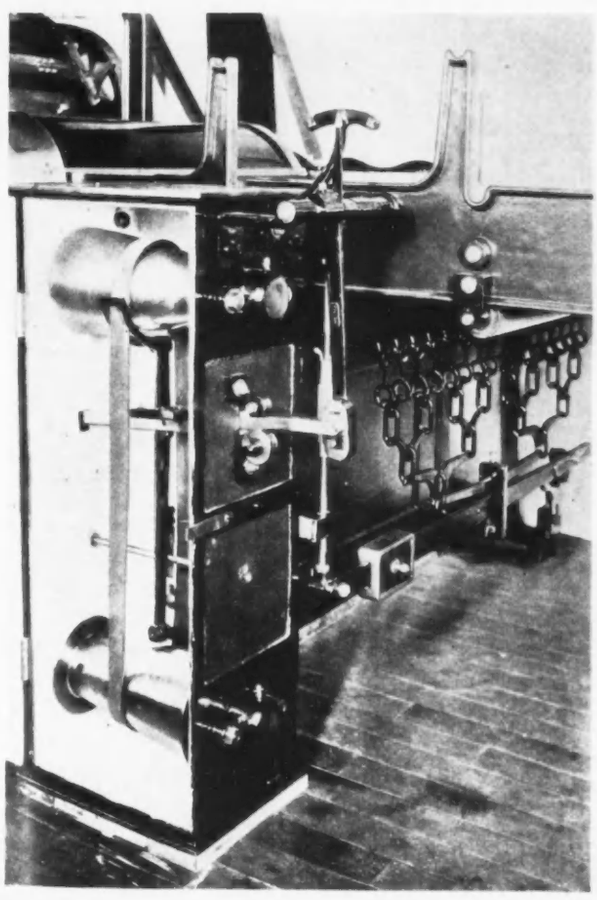
usual objection of excessive weight of cast iron is not present because most of the guards are relatively small. One of the advantages of cast-iron guards is that they are not easily damaged or knocked out of shape. However, the predominating reason for using cast-iron gear guards is probably because of the variety of shapes and sizes required. To press them out of sheet steel would require a tremendous number of dies. Furthermore, the manufacturers making these machines have well-equipped foundries.

Just ahead of each screen section is a glass window in order that the operator may be able to see the amount of cotton in the chamber ahead of the screen cage.

The beaters are provided with covers or bonnets, hinged so that they may be lifted and the beaters inspected. Opening these bonnets when the beater is rotating would be dangerous. Therefore, the machine is equipped with a mechanism that makes it impossible to open either the glass inspection door ahead of the screen or the cover of the beater when the machine is running. Nor can the machine be started when either of these is open.

Flat leather belts are used except where positive drive is necessary to maintain uniform feeding. In that case, chain drives or gears are used. Several factors make leather belts preferable. Cost is one, but not a dominating one. Beaters and enticing rolls strike the cotton with great velocity, causing a series of blows which the belts absorb. They may be shortened or lengthened easily. Lastly, they provide safety by slipping off if the machine is started with the beater cover open.

AUTOMATIC control of all feeds from the intermediate feed hopper to the finisher section is obtained through the evener motion



Books for Engineers

MATERIALS HANDBOOK. SECOND EDITION. *By George S. Brady, Managing Editor, Product Engineering. 588 pages, 4x6¾ in. Indexed and appendixed. Flexible clothboard covers. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Price $5.*

THE development and increasing use of a great variety of engineering materials has been the outstanding change in the world's industrial life during the last several years. As a result, the engineer, purchasing agent, and industrial executive find it increasingly important to have an encyclopedia of these materials, with chief characteristics, comparative data, substitutes, and sources, at their fingertips. This standard reference work was developed with that idea in mind. The second edition is enlarged by one-half, listing some 2,400 materials in 1,526 material groups, the information being alphabetically arranged and from authoritative sources.

Several advantages of the second edition over the first will be apparent to the comparer. A comprehensive index, giving page numbers and cross references, has been included to make the search for any material much simpler. The appendix has also been improved considerably by the addition of a variety of tables and charts of use to the product engineer and designer. The author includes short descriptions of basic materials and ores in order to provide a background for the engineering materials developed, and makes no effort to provide purely metallurgical or chemical information or to give an exhaustive treatise on any one material. It is, as its name implies, a handbook, and as such, will find an indispensable place on the design desk or in the pocket of any man having to do with materials and their uses. Further, student engineers will find in it a book comparable with the standard handbooks for value, both while in college and in after life.

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TREATISE ON LEATHER BELTING. *By Profs. George B. Haven and George W. Swett, Massachusetts Institute of Technology. 249 pages, 8x5-in. Indexed, and thumb indexed. Clothboard covers. Published by the American Leather Belting Association, 41 Park Row, New York, N. Y. Price $1.50.*

FOUR groups of readers and their needs were considered in the compilation of this treatise on leather belting: engineers and engineering students; purchasing agents, for specifications and inspection data; mill engineers, for methods of computing installations from both practical and theoretical standpoints; and millwrights for requirements on installation and care of leather belting.

New nomographic charts constitute a feature of the book, and have been selected for their value in the usual mill problems. A large number of mathematical tables have also been included, representing the compilation of data from the various members of the association.

STRESSES IN RINGS
Of Symmetrical Cross-Sections

By P. FIELD FOSTER, M.Sc.
University College, Cardiff, Wales

ANALYSES of stresses in rings of symmetrical cross-section, as presented in this article, are directly applicable to chain links, lifting eyes, and similar constructions. The author shows how to calculate the shifting of the neutral axis for curved beams in general. Derivations of formulas for cross-sections commonly used are given for certain proportions so that by simple substitutions in the derivations, formulas for other proportions may be obtained easily.

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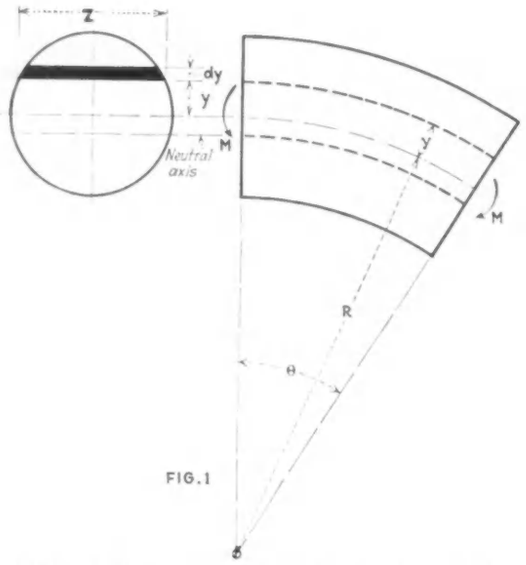


ELEMENTS of a curved beam showing the deviation of the neutral axis from the center of gravity section

THE fundamental relations which form the basis for the usual stress calculations on straight beams subjected to bending moments are expressed by the equation:

$$\frac{f}{y} = \frac{M}{I} = \frac{E}{R} \qquad (1)$$

where

- f is the stress at a distance y from the axis through the centroid of a section of the beam perpendicular to the plane of bending
- M is the bending moment
- I is the moment of inertia of the cross-section about the neutral axis
- R is the radius of curvature of the longitudinal axis of the deflected beam
- E is the modulus of elasticity

Under the same assumptions as those on which the derivation of the above formulas rest, the relations given may be applied without much error to cases where the initial curvature of the longitudinal axis of the beam is appreciable. Assuming the stress to vary as the distance from the central axis of the cross-section of the beam, if R is the initial, and ϱ the final radius of curvature, the above relations become:

$$\frac{f}{y} = \frac{M}{I} = E\left(\frac{1}{\varrho} - \frac{1}{R}\right) \qquad (2)$$

When, however, the curvature of the beam is great, the stress, instead of being given by the simple formula $f = \frac{M\,y}{I}$, is given by:

$$f = \frac{M}{R(A' - A)}\left(\frac{A'}{A} - \frac{R}{y + R}\right) \qquad (3)$$

where A is the area of the cross-section and A', termed the "derived area," is equal to $\Sigma\left(\frac{R}{y+R}\,\delta a\right)$. The elementary area δa equals $z\,dy$, as shown in Fig. 1.

Equation 3, containing the variables f and y, is of the form:

$$x = a - \frac{b}{y + c}$$

or $$xy + xc - ay + b - ac = 0 \qquad (4)$$

The general equation of the second degree in two variables is of the form:

$$Ax^2 + 2Hxy + By^2 + 2Gx + 2Fy + C = 0,$$

where the coefficients are constants. It can be shown that if AB is less than H^2 the equation denotes a hyperbola. In equation 4, the coefficients A and B are both absent, being equal to zero, and hence the variation of stress with distance from the central axis of the curved beam is hyperbolic. Moreover, equation 3 shows that the neutral axis, at which the bending stress is zero, is not co-incident with the axis through the centraid, for, when f is made equal to zero, the distance y between the axes referred to is:

$$y = R\left(\frac{A - A'}{A'}\right)$$

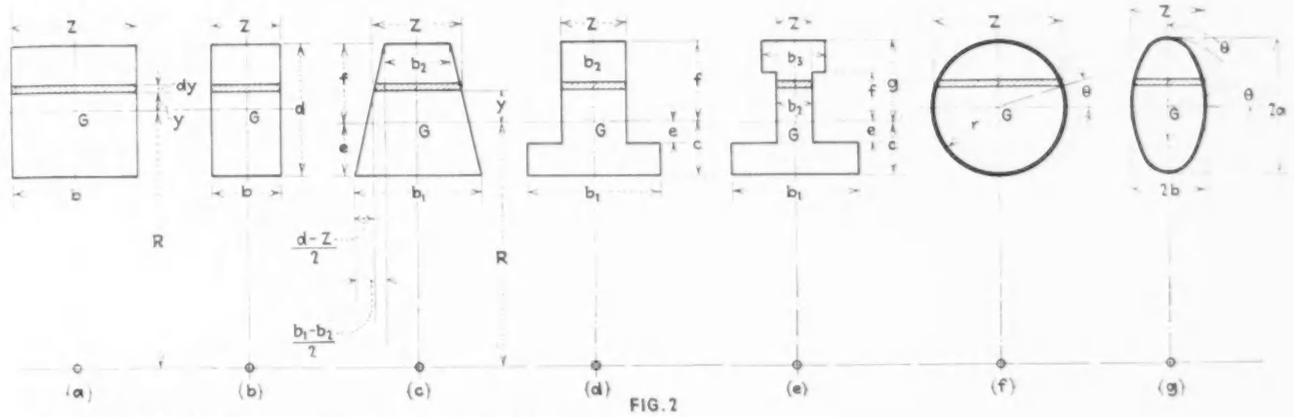


FIG. 2

SYMMETRICAL cross-sections. Diagrams used for developing formulas for calculating the derived area

Since A' is greater than A, this value of y, as shown in Fig. 1, is negative.

Formulas for calculating A' will now be given. For future convenience the quantity A'/A will be denoted by m.

Rectangular Section, Figs. 2a and 2b.

This is the general case of the rectangle. Breadth of section $= b$. Radial depth $= d$. Radius to centroid $G = R$.

In this case $\delta a = z\,dy = b\,dy$

Hence

$$A' = \Sigma\left(\frac{R}{y+R}\,\delta a\right) = \int_{-\frac{d}{2}}^{\frac{d}{2}} \frac{R\,b\,dy}{y+R}$$

$$= Rb\log_e\frac{2R+d}{2R-d}$$

$$= 2.3026\,Rb\log_{10}\frac{2R+d}{2R-d} \qquad (5)$$

As $A = bd$

$$m = 2.3026\left(\frac{R}{d}\right)\log_{10}\frac{2\frac{R}{d}+1}{2\frac{R}{d}-1} \qquad (5a)$$

For the square section $d = b$ in the equation 5.

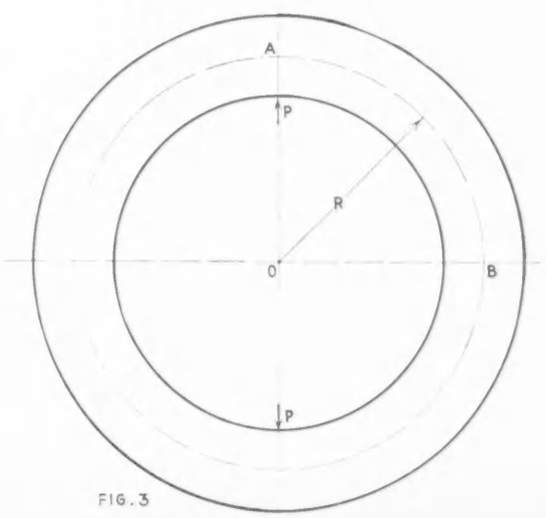


FIG. 3

CIRCULAR ring under tension load

Trapezoidal Section, Fig. 2c.

Breadth at outer surface $= b_2$. Breadth at inner surface $= b_1$. Radial depth $= d$.

$$e = \frac{4}{9}d; \quad f = \frac{5}{9}d, \quad \text{with } b_1 = d \text{ and } b_2 = \frac{d}{2}$$

From similar triangles as shown in the figures:

$$\frac{b_1 - b_2}{d} = \frac{d - z}{\frac{4}{9}d + y}$$

or

$$z = \frac{7}{9}d - \frac{y}{2}$$

$$A' = \Sigma\left(\frac{R}{y+R}\,\delta a\right) = \int_{-e}^{+f}\frac{R}{y+R}\left(\frac{7}{9}d - \frac{y}{2}\right)dy$$

$$= \frac{R}{18}\left[-9d + (14d+9R)\,2.302\log_{10}\frac{9R+5d}{9R-4d}\right] \qquad (6)$$

As $A = \frac{3d^2}{4}$

$$m = \frac{A'}{A} = -\frac{2R}{3d} + \frac{4.605}{3\times 9}\left[\frac{14R}{d} + 9\left(\frac{R}{d}\right)^2\right]\log_{10}\frac{\frac{9R}{d}+5}{\frac{9R}{d}-4} \qquad (6a)$$

Inverted Tee-Section, Fig. 2d.

Breadth of flange, $b_1 = d$. Breadth of web, $b_2 = \frac{d}{2}$

Thickness of flange, $c - e = \frac{d}{4}$

$$A' = \int_{-e}^{-e}\frac{Rb_1}{R+y}\,dy + \int_{-e}^{+f}\frac{Rb_2}{R+y}\,dy$$

$$= [Rb_1\log_e(R+y)]_{-e}^{-e} + [Rb_2\log_e(R+y)]_{-e}^{+f}$$

$$= 2.3026R\left[b_1\log_{10}\frac{R-e}{R-e} + b_2\log_{10}\frac{R+f}{R-e}\right] \qquad (7)$$

With the proportions adopted:

$$c = \frac{17\,d}{40}, \quad e = \frac{7\,d}{40}, \quad f = \frac{23\,d}{40}$$

$$A = \frac{d\times d}{4} + \frac{d}{2}\times\frac{3\,d}{4} = \frac{5}{8}\,d^2$$

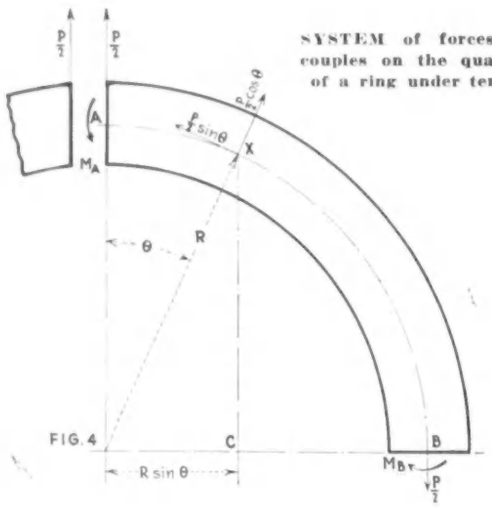


FIG. 4

SYSTEM of forces and couples on the quadrant of a ring under tension

Hence

$$m = \frac{A'}{A} =$$

$$2.302 \times \frac{8R}{5d}\left[\log_{10}\frac{40\frac{R}{d}-7}{40\frac{R}{d}-17}+\frac{1}{2}\log_{10}\frac{40\frac{R}{d}+23}{40\frac{R}{d}-7}\right]$$

Section, Fig. 2e.

Breadth of inside flange, $b_1 = d$. Breadth of web, $b_2 = \frac{d}{4}$. Breadth of outside flange, $b_3 = \frac{d}{2}$. Thickness of flanges $= \frac{d}{4}$.

$$A' = \int_{-e}^{-c}\frac{Rb_1}{R+y}\,dy+\int_{-e}^{+f}\frac{Rb_2}{R+y}\,dy+\int_{+f}^{+g}\frac{Rb_3}{R+y}\,dy$$

$$= 2.3026R\left[b_1\log_{10}\frac{R-c}{R-e}+b_2\log_{10}\frac{R+f}{R-e}+b_3\log_{10}\frac{R+g}{R+f}\right] \quad (8)$$

With the proportions given, $c = \frac{13}{32}d$; $e = \frac{5}{32}d$; $f = \frac{11}{32}d$; $g = \frac{19}{32}d$; $A = \frac{d^2}{2}$

$$m = \frac{A'}{A} = 4.605\ \frac{R}{d}\left[\log_{10}\frac{32\frac{R}{d}-5}{32\frac{R}{d}-13}+\frac{1}{4}\log_{10}\frac{32\frac{R}{d}+11}{32\frac{R}{d}-5}+\frac{1}{2}\log_{10}\frac{32\frac{R}{d}+19}{32\frac{R}{d}+11}\right] \quad (8a)$$

Circular Section, Fig. 2f.

Radius $r = \frac{d}{2}$; $y = r\sin\theta$; $z = 2r\cos\theta$; $dy = r\cos\theta\,d\theta$; $\delta a = z\,dy = 2r^2\cos^2\theta\,d\theta$.

Therefore:

$$A' = \Sigma\left[\frac{R}{R+y}\delta_a\right] = \int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}}\frac{2Rr^2\cos^2\theta\,d\theta}{R+r\sin\theta}$$

The final expression for A' is:

$$A' = 2\pi R(R-\sqrt{R^2-r^2}) \quad (9)$$

and $$m = \frac{A'}{A} = 2\left(\frac{R}{r}\right)^2\left[1-\sqrt{\left(\frac{r}{R}\right)^2}\right] \quad (9a)$$

Elliptical Section, Fig. 2g.

Major Axis $= 2a = d$. Minor Axis $= 2b = \frac{d}{2}$

If θ' be the eccentric angle of the ellipse and θ its complement:

$$y = a\cos\theta' = a\sin\theta;\ dy = a\cos\theta\,d\theta;$$
$$z = 2b\sin\theta' = 2b\cos\theta.$$

Hence:

$$A' = \int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}}\frac{R\,2\,a\,b\cos^2\theta\,d\theta}{R+a\sin\theta}$$

which is the same form as for the circle and gives:

$$A' = 2\pi R\,\frac{b}{a}\,(R-\sqrt{R^2-a^2} \quad (10)$$

$$A = \pi ab$$

$$m = \frac{A'}{A} = 2\left(\frac{R}{a}\right)^2\left[1-\sqrt{1-\left(\frac{a}{R}\right)^2}\right] \quad (10a)$$

Considering now the stresses in a ring subjected to a direct pull P, as in a chain in tension, the usual method of determining the bending moment at any section is as follows:

Referring to Fig. 3, we note that the sections of the

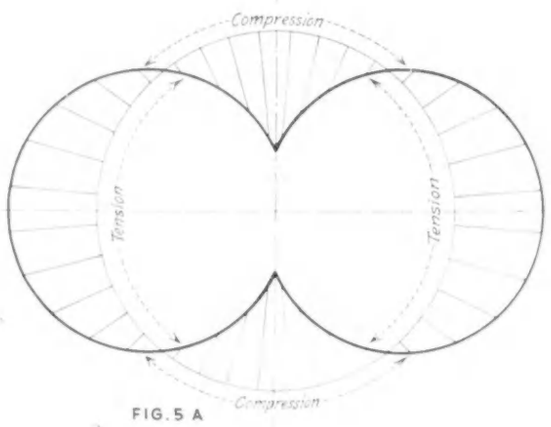


FIG. 5 A

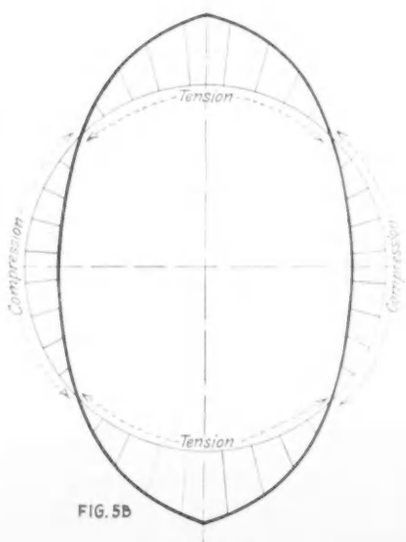


FIG. 5B

STRESS distribution around inside of ring is shown at *A*, and at *B* is shown the distribution around the outside, the loads being applied as shown in Fig. 3

ring at A and B do not change their angular relationship under load and that all quadrants are similarly stressed. The angular change $\phi = \int_A^B \frac{A}{EI}\,ds$ due to bending, is zero. Hence:

$$\int_A^B \frac{M}{EI}\,ds = 0 \qquad (11)$$

Let M_A, M_B and M be the bending moments at A, B and X respectively; the section at X being inclined at

Table I

Mean Radius / Depth of Section $\left(\frac{R}{d}\right)$	1	1.5	2	3	5
Section	Values of m				
(a) (b)	1.0986	1.0397	1.0217	1.0094	1.0033
(c)	1.0875	1.0363	1.0200	1.0085	1.0032
(d)	1.0948	1.0401	1.0223	1.0098	1.0036
(e)	1.0830	1.0455	1.0255	1.0113	1.0034
(f) (g)	1.0720	1.0276	1.0144	1.0080	1.0002

an angle θ to OA as in Fig. 4. On the quadrant AB there will be a pull $P/2$ at A and an equal and opposite pull $P/2$ at B. The part BX of the quadrant is in equilibrium under the system of forces and couples shown. Taking moments about X we have:

$$M = M_B + \frac{P}{2}BC$$
$$= M_B + \frac{P}{2}R(1 - \sin\theta) \qquad (12)$$

The linear element ds of the center line AB equals $R\,d\theta$. Hence, substituting the value of M from equation 12 in 11 we have:

$$\int_0^{\frac{\pi}{2}} \frac{MR}{EI}\,d\theta = \frac{R}{EI}\int_0^{\frac{\pi}{2}} \left[M_B + \frac{P}{2}R(1 - \sin\theta)\right]d\theta$$

$$= \frac{R}{EI}\left[M_B\frac{\pi}{2} + \frac{PR\pi}{4} - \frac{PR}{2}\right] = 0$$

This gives $$M_B = \frac{2}{\pi}\left(\frac{PR}{2} - \frac{PR\pi}{4}\right) = \frac{PR}{2}\left(1 - \frac{\pi}{2}\right)$$

and $$M = PR\left(\frac{1}{\pi} - \frac{1}{2}\sin\theta\right) \qquad (13)$$

This is a maximum when $\sin\theta$ equals zero, that is, when $\theta = 0$, or at the section at A. The bending moment at this section is then:

$$M_A = 0.318\,PR \qquad (14)$$

It is easily seen that the the bending moment at B is:

$$M_B = -0.182\,PR \qquad (15)$$

A closer investigation which does not neglect the initial curvature of the ring and the effect of the normal forces, leads to the more exact expressions:

$$M = PR\left(\frac{1}{\pi m} - \frac{\sin\theta}{2}\right) \qquad (13a)$$

$$M_A = \frac{0.318\,PR}{m} \qquad (14a)$$

$$M_B = PR\left(\frac{1}{\pi m} - \frac{1}{2}\right) \qquad (15a)$$

The values of A' and M having been found, the bending stress at any section of the ring can be calculated by equation 3 given above.

In addition to the bending stress there is on every section an axial force $\frac{P\sin\theta}{2}$ and a shear force $\frac{P\cos\theta}{2}$

The additional axial stress is $\frac{P\sin\theta}{2A}$, which is a maximum at B.

The average shear stress on the section is $\frac{P\cos\theta}{2A}$

but, as the shear is not uniformly distributed, the maximum shear stress is greater than this—in the case of a circular section by about 33 per cent. The shear is not however, of great importance, being small where the bending is great and vice versa.

The total axial unit tensile stress is given by:

$$f\ \frac{M}{RA(m-1)}\left(m - \frac{R}{y+R}\right) + \frac{P\sin\theta}{2A} \qquad (16)$$

The greatest tension occurs at the outside of the section at A. Whether the maximum tension occurs at A or B depends upon the relative dimensions of the cross-section and the diameter of the ring. Fig. 5a shows how the stress varies around the circumference of a ring on the inside and Fig. 5b shows the variation around the outside. The ordinates are laid off along the radial lines to the center from the mean circle of the ring as a base.

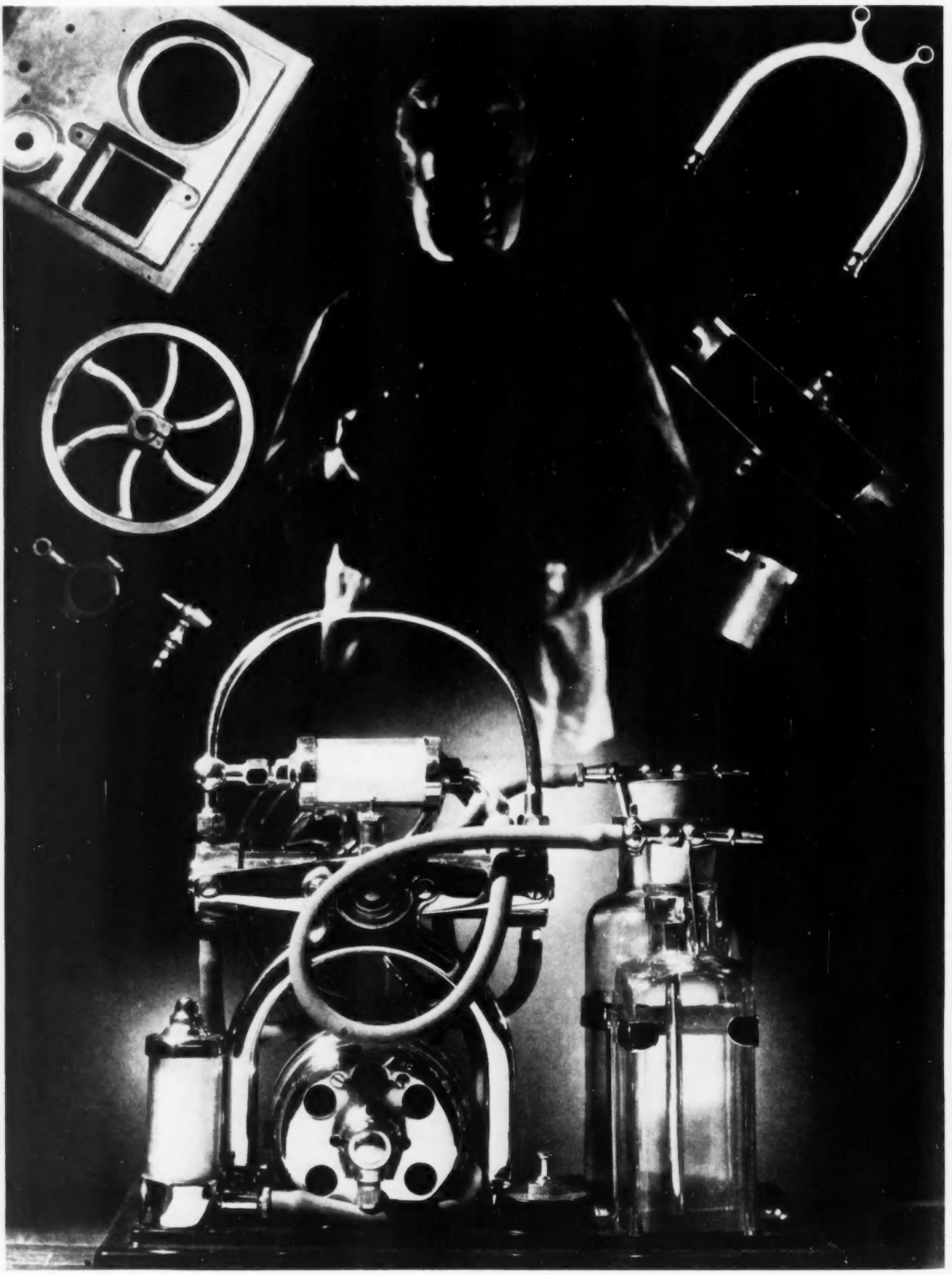
Provided the proportions adopted for the sections are as shown in Figs. 2c, 2d, 2e and 2g, the quantity m becomes a function of the ratio R/d for all the sections. A set of values of $m = A'/A$ for the sections illustrated is therefore given in Table I for various values of R/d. With the reservation mentioned the values given apply for curved beams generally.

Table II—Stresses in and relative weights of ring sections shown in Fig. 2

Stresses in lb. per sq.in. per lb. of load in rings of 4-in. mean radius and 2-in. depth of section

Type of section	Section A—Fig. 4 Inside Compression	Section A—Fig. 4 Outside Tension	Section B—Fig. 4 Inside Tension	Section B—Fig. 4 Outside Compression	Relative Weights
(a)	1.125	0.795	0.804	0.359	1.00
(b)	2.23	1.59	1.605	0.717	0.50
(c)	1.628	1.144	1.153	0.529	0.75
(d)	1.735	1.24	1.253	0.554	0.625
(e)	1.873	1.372	1.391	0.588	0.5
(f)	2.212	1.488	1.471	0.725	0.785
(g)	4.43	2.98	2.948	1.452	0.393

Table II gives the maximum unit stresses per pound of load for the sections shown in Fig. 2, and also gives the relative weights of the cross-sections. The table has been calculated with the aid of the exact formula.



Zinc-base die castings constitute the major parts of this expensive machine, a surgical pump. The plunger parts work together without machining. Appearance counts

MATERIALS
HELP MAKE SALES

A FEW YEARS AGO, designers were using only a fourth of the fifty known elementary metals. Today, practically all of them are employed in product engineering. Moreover, by the development of an amazing variety of alloys, the older engineering materials, such as iron, steel, brass, and bronze, have found new and wider applications. The engineer also reaches out to the chemical field for such materials as the molding plastics, and he finds new uses for glass, woods, soft, hard, and plastic rubber, fibers, and materials once considered limited to building construction.

Attention to corrosion resistance in the growth of the American chemical industries since the war period has been a large factor in new material development. Tank car construction is typical of what has been done. Several years ago the rubber-lined car was developed for handling acids. Glass-lined cars, with the glass applied by spray-gun, then fired, are now used for transporting milk. In providing a shock-absorbing medium for the glass-lined tanks, a cork insulating shell was developed, which also proved useful as an insulator to keep the milk cool. One company has developed all-aluminum cars for handling such chemicals as formaldehyde. An additional advantage in the light weight is the saving of transportation costs. The need for transportation of caustic soda for the new rayon industry has been met with nickel-clad steel plate. Pure nickel, Monel metal, copper, and high-alloy steels may yet be adopted for cars transporting specific liquids where the use warrants the expense, although some difficulties have been encountered.

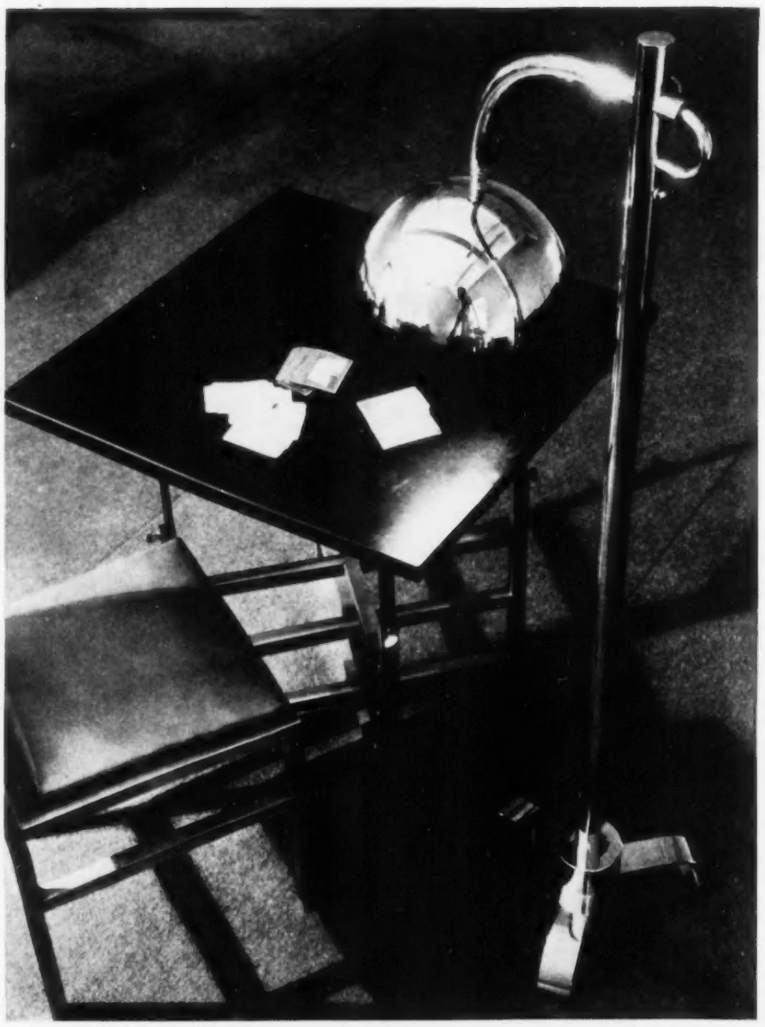
The great advances in the mechanization of the food manufacturing industries has given opportunity for the use of a wide variety of metals and alloys. It has been carried to the development of solders, welding rods and fluxes, facing materials, plates, and finishes to meet specific requirements for corrosion resistance, heat resistance, wear resistance, non-staining and non-contaminating of foodstuffs. Proved uses can now be found in general products for almost any of the materials of commerce. Solid nickel and pure iron, together with pure aluminum and copper, find use

12-IN.-DIAMETER screw conveyor cast of high-alloy steel for abrasion and heat resistance. It shows the possibility of high-strength steel castings in difficult shapes

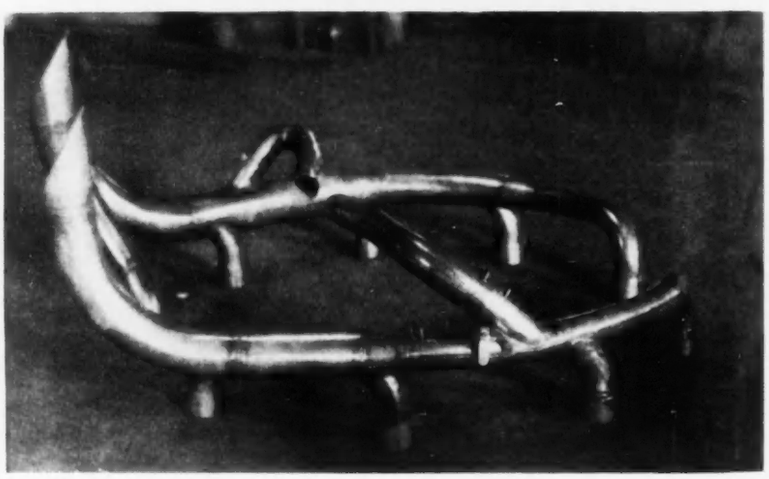
in corrosion resistance, as does carbon in tube form. Plated finishes are frequently resorted to for obtaining a degree of corrosion resistance or for appearance. Nickel is still the most common plating material, in spite of the popularity of chromium. The latter, however, has found application in the plating of turbine blades to resist erosion, in addition to its more commonly known uses. Soon the engineer will have available the rarer materials, rhodium, palladium, selenium, and cadmium. The last-named is now being used to plate a variety of small parts, such as bolts, nuts, and small drop forgings. Rhodium gives a non-tarnishing plate almost indistinguishable from silver plate, but having much greater hardness. Palladium gives a plating similar to platinum. Comparative costs, giving platinum plating a value of 1, are 2.75 for palladium and 2.4 for rhodium. Selenium, available in great quantities if uses are found for it, is serving in the chemical, medical, and rubber industries.

Under careful control, it is possible to co-deposit metals on a suitable base. Nickel and cobalt, for example, have been so plated to gain a silvery appearing plate. The quality of plating is being steadily improved as the result of improvement in processes of cleaning the surfaces previous to plating.

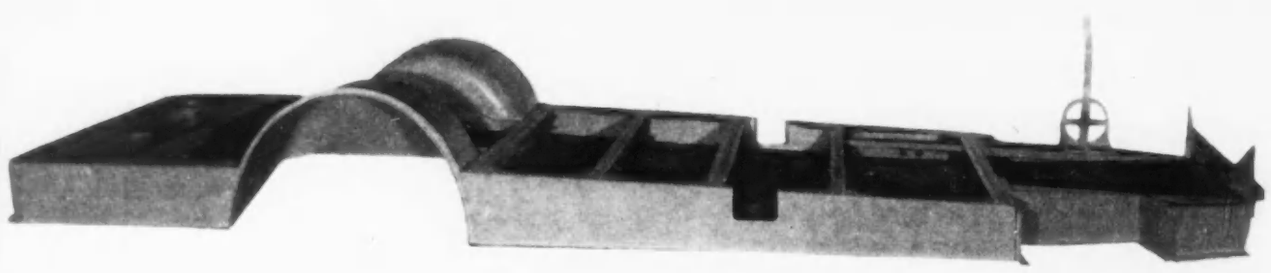
Among the rarer metals finding direct or alloyed applications is tungsten, now being produced 99.5 per cent pure for commercial electrical parts. It is workable,



NEW MATERIALS find an impressive place in present-day furniture and interior fittings. Chair and table legs in this group are welded aluminum, the lamp is welded steel chromium plated, and the table top is of black Formica



AIRCRAFT NEEDS resulted in much of the impetus given new methods of fabrication. This welded chrome-nickel steel exhaust manifold for an aircraft engine is a striking example of what is being done in regular production



SHEET METAL has entered the construction of bus bodies and chasses to such an extent recently that what were formerly wood-working plants are being transformed into metal-working plants. An alloy-steel channel frame with pressed mounting shoes is shown

ductile, yet has the highest melting point of any metal. At the opposite extreme is indium, meltable in the heat of a match, and white, soft, lustrous, and ductile, which will be commercially available in the near future. Beryllium, half as heavy as aluminum, and valuable as a hardener for metals and alloys, is now available at about $150 a pound, but the price will be lowered with advances in production methods and increased use. Tantalum, steel colored, erosion and acid resistant, is also sprayed on turbine blade edges, and probably will find great future use in alloys.

An example of the rapid strides in the application of new metals is shown by magnesium, 30 per cent lighter than aluminum by weight. In the past eight years, its use has increased twenty fold, and its price has been lowered steadily, so that it sells now for around 48 cents a pound. Its future use will probably be in parts where minimum weight is essential. Lighter than magnesium are lithium and sodium, both lighter than water. They are used in bearing metals and as hardeners for lead. Caesium and rubidium, from the same group of metals, are used in alloy form for radio parts. Columbium, with its beautiful white color and great degree of corrosion resistance, is being used for watch cases. Antimony is being used as a hardening agent in increasing amounts.

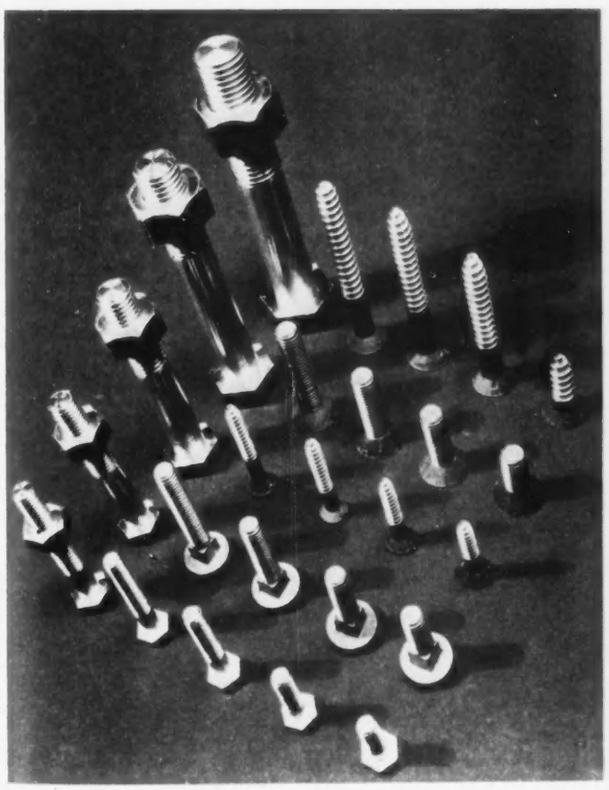
A vast field is opening for the plastics and other molded materials. There are two principal types of plastic molding materials: thermo-plastics, such as the cellulose acetates, worked under heat and pressure and reworkable; and thermo-setting plastics, such as the phenol-formaldehydes, which take a permanent set under heat and pressure and cannot be reworked.

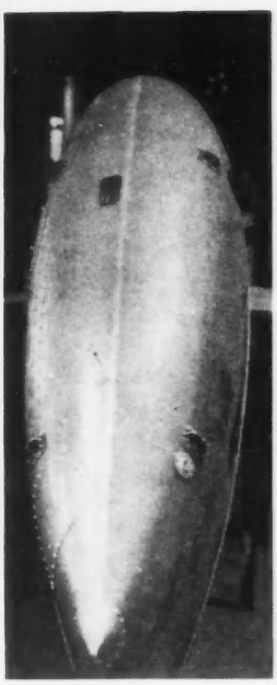
Not only must the product engineer follow closely the progress in metals and molded plastics; but he must follow the progress in common non-metallic materials as well. New uses are being found constantly for vulcanized fibers, cork, and felt insulation, and felt wicking, paper, asbestos, and textile packings and gaskets, papier maché, ceramics, and moldable earths. As an example, Celotex is now being used as a heat insulator in automobile bodies. Certain of the expensive minerals are being regularly applied in point-sealing compounds, and other materials for this sort of work have been developed which remain permanently plastic under all sorts of operating conditions. In England, an inventor claims to have devised a method of molding thin asbestos sheeting, resilient and non-brittle, for molded fireproof auto bodies.

Developments in manufacturing processes are also contributing their share in widening the field of selection of the enginering materials. Stamping, forming, casting, die casting, forging, welding, brazing, soldering, and other processes are vying for attention, progress in one affecting the field of application of the others. Closer limits obtainable in drop forgings, development of new welding rods, fluxes, and procedures, improvements attained through tool development, such as the application of new cutting alloys or of hydraulic principles, all contribute to the ever-changing aspect of the field of engineering materials.

Specifications for finishes other than plating also present a wider range, each type of finish now available being particularly adaptable for some certain set of conditions. Lacquers are made to specific formulas to meet conditions, vitreous enamels are being developed for wider adaptation, and a vast array of japans and paints are presented for the engineer's selection. He also has available materials which require little or no finishing and a variety of methods for coating or hardening surfaces.

It is an increasingly important and difficult task for the product engineer to select for his particular purpose those materials best suited in price and characteristics for his particular design. Not only must materials be selected, but the method of fabrication and processes involved must also be specified. To keep abreast of progress in materials is becoming an increasingly difficult task, but only by so-doing can the designer hope to apply those materials most applicable to the particular design.





✦

STRONG ALLOYS of aluminum can now be riveted and welded in a variety of shapes as the result of the need of the transportation industry for lighter materials. This is a Duralumin pontoon

USE of aluminum alloys lead to the development of standard screw machine parts in aluminum which match in color and prevent electrolysis in the structures

Photographs from
Linde Air Products Company
New Jersey Zinc Company
Chicago Steel Foundry Company
Bender Body Company
Aluminum Company of America

Needed in the Product — ART EXPRESSION

By O. KUHLER
Design Engineer

DEVELOPMENT of new standards of beauty has run parallel to technical improvement, but often the developments have been severely hampered by having taken over standards of beauty from products of the remote past. Our "slick-looking" motor cars were originally buggies without horses. The line between motor manufacturer and coachbuilder was well defined at the dashboard in the earliest motor cars. While the motor manufacturer dared to build a cone-shaped hood, knowing that he was presenting something new, he stopped at the dashboard and left the rest to the coachbuilder. In his pride, which every craftsman has, the coachbuilder stuck to his trade and continued his work along the lines that by tradition had been established.

When back in 1912 I dared to design a limousine with enclosed steering wheel, hundreds of objections were brought to me about flying glass, the listening chauffeur, and such. All these objections have since been dissipated. When a well known continental coachbuilder finally began building a car along these new lines, it was acclaimed, exhibited, praised, and is in general adaption today.

It took the artist to bring the two manufacturers together. Many types of cars running now appeared ten years ago in advertisements in which something else was advertised and the automobile was only a part of the illustration. They were visualized by men who did not know much about motor cars technically.

Ships, yachts, motor boats, buildings, bridges —all were visualized sometime before their actual construction by someone with an idea. Witness, for example, the splendid illustrations Hugh Ferriss drew for the American Institute of Steel Construction. Or consider the dreams of Jules Verne about rockets, submarines, radio and other devices that have since come into existence. While we may agree that this creative force exists, it has been apparently rather difficult to put to practical use.

Our machine age has given us many new materials, but we do not always use them; as a matter of fact, we often hide the material. Steel is painted to look like wood. Literally, we build Gothic cathedrals around a steel frame. Many products are made to look like what they are not, a procedure usually involving much extra expense.

Instead of being frank with the public in seeking the beauty in the material itself and expressing it in lines to which manufacturing and practicability should lead us, we are afraid of our market. The radio manufacturer actually goes into the furniture business. It is foolish to try to design a good looking radio cabinet that is at the same time as Gothic as it is Colonial, or that will harmonize with the furniture of all homes. Why not solve this problem in a way similar to that in which the medicine cabinet problem was solved? Provide a space of enough depth in the wall of the modern home and conceal the mechanism as is being done with light plugs and switches. In other words, install the radio out of sight. Already, midget sets indicate this tendency. Radios of all brands may be standardized to fit into a standard space. There the instrument will be free from vibrations, dust, and will not take up valuable room space.

While we claim that the present-day steam locomotive has a right to be called modern, we

do not attempt to make it look so. While it has achieved structural beauty through sheer technical development, it has only the beauty of a stationary engine. Railroad leaders agree that the picture of an on-rushing steam locomotive still has the strongest appeal to the public, but we do not cut down wind-resistance or maintenance cost by building accordingly.

With a drawing of a very normal type of locomotive one may visualize what design engineering can do to the iron horse. Without touching any part but the stack the entire expression of the engine may be changed. This applies to most other products as well, but it does not mean that to change the design of a table lamp, one must have a lot of ornaments plastered on it.

Manufacturing concerns, realizing the value of a practical and beautiful product, make attempts at improvement. This has largely been done in spots and patches, and today only few products express in their exterior appearance the brand that made them. That is all left to the trademark. The trademark should really be the base on which to start a line of products and should not be slapped on afterwards. Trademarks have had a strong appeal when they were simple and without a style or period. In the case where they are fully executed pictures with many details, they have cost and will cost the manufacturer much money. A good trademark should be designed so that it can be reduced very small or greatly enlarged, so that it can be stamped, stenciled, printed, cast, etched, hewn in stone or woven in the house flag. That is the ideal trademark, and it is a part of the product.

On ne passe pas!

Sometimes it would seem that the famous expression written on the citadel of Verdun is also inscribed on the walls of many engineering departments. "They shall not pass" —meaning new ideas.

There is a subtle feeling that a certain class of manufacturer has a secret motto—"Not the first, and not the last." Hence the effort to copy designs and rush into fads.

Product engineers need more and more to shake off the cobwebs of tradition, and put art, form, and sales value, in addition to technical utility, into their products.

Where manufacturers form objective bulwarks against outside ideas, they may expect to find difficult sales resistance for their own products that do not meet customer needs.

"They shall not pass" works both ways!

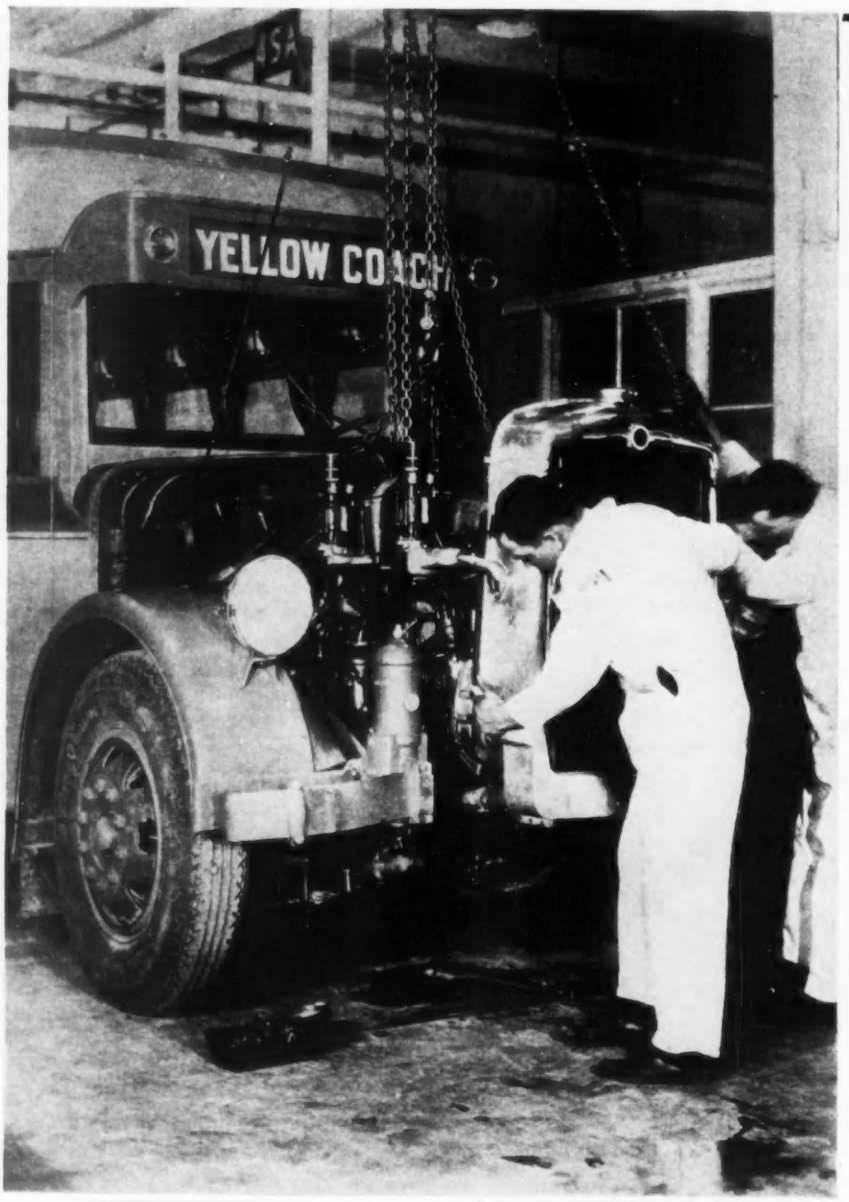
With the appearance of materials based on new alloys in steel, aluminum, and chromium, we shall have to think of new uses. While some of these materials have already found good outlets, there are still an unlimited number left if we think of discarding old manufacturing practices. If we figure out how many tons of steel are dragged around on rails daily to carry relatively small pay loads, it is easily visible where a market for lighter materials will eventually find their outlet.

The housewife can be relieved of a lot of drudgery by new materials. Fire safety can be increased and maintenance cost decreased. It is only natural to assume that these points will also mean new sales arguments that will make merchandising easier. The old ice-box was made of wood. The refrigerator that followed it was at first nothing else but a wooden box with refrigerating machinery. When we realized that they are by no means the same thing, we got beautifully enameled steel refrigerators and the public was made to feel that this new product was not an ice-box any longer.

The designer comes in on all this at the start. Many mistakes can be avoided if he is consulted. Why, for example, does one automobile manufacturer copy the other? Why always leave it to the public to find out and reject mistakes? It is the designer's job to point out these errors from the start.

The vogue of copying one car from another in the automobile industry has led to a radiator form that is almost standard. The individuality expressed in radiator lines about five years ago has been lost. If manufacturers, instead of watching their competitors frantically, would go back and take their old outstanding designs, improve on the lines, and build their cars progressively from one point to another, we would have real improvement. The artistic temperament of the buying public must be consulted in all moves of the designer.

While this is true of automobiles, it also applies to every other product to a certain degree, be it a small electric appliance or a giant ocean liner. On the other hand, it is just as foolish to overdo the problem and leave it all to the artist. A lack of manufacturing knowledge will produce a design that at first glance might appear beautiful, but may be expensive to manufacture and to sell.



SERVICE

the Yellow Coach

Designed In

AN INTERVIEW WITH
G. A. GREEN
Vice-President In Charge of Engineering, General Motors Truck Corporation

✦ More than half a million dollars a year goes into this company's program of product development. It is budgeted, and must show results in sales value of the product.

✦ A responsibility is assumed by the development engineers that a product is provided for marketing that meets the needs of the user, where "educational" campaigns of "high-pressure salesmanship" will not be required.

✦ Engineers studied the market from the standpoint of the public, the driver, and the operating company. The result was a bus in which the sales department could show:

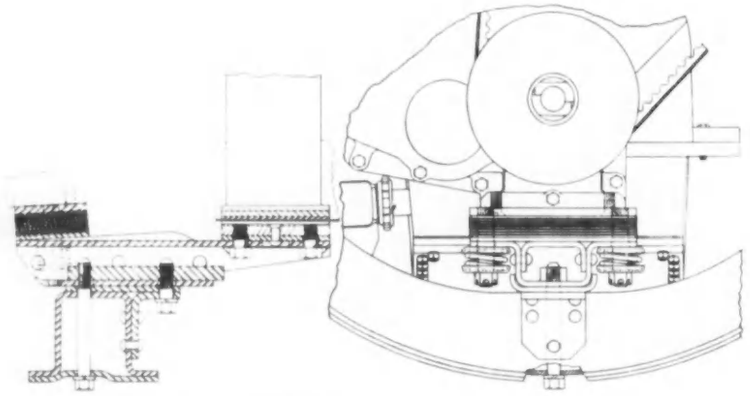
Improved appearance with equal utility Travel comfort	The public
Easier control Higher speed and acceleration More power	The driver
Simplified but stronger construction Fuel economy Quick, easy maintenance	The operator

✦ Engineering moves onward, and the bus described in this article is another step in design advance of the one that met sales success in 1930.

THAT ENGINEERING was one of the prime functions in the development of the new Yellow Coach is seen by the fact that the company spends more than half a million a year on engineering. The design of the V-type coach represents the accumulated experience of the entire organization, including engineering, manufacturing, sales, and service. It represents the studies made by these departments, co-ordinated with the suggestions made by leading coach operators, into a final design that could be offered by the sales force to the purchasers as a product that would give maximum efficiency in operation with minimum service requirements.

Engineering at the General Motors Truck Corporation is in charge of a vice president and the work is housed in a two-story separate building with the modern equipment and the organization of 250 employees arranged for putting the work through on a production basis. Engineering is a dynamic force in the development of the product of the company. Trained men attached to the engineering division follow down every complaint or suggestion coming from the field. Promising suggestions, after due development and test, are incorporated into the designs. When an entirely new design is projected, it is developed in a special new-development section, and models are built and given actual running tests before the final design drawings are made for the shops. When the new model is finally ready for marketing all salesmen are brought into the factory where they are given practical instruction on the test floors of the engineering division in all of the mechanical features of the new bus. Finally, the engineering division never relinquishes responsibility for the proper functioning of the machine in the hands of the operator. Engines and other units are withdrawn from the production lines in the shop and given service tests. As all engineering expenditures of the company are on a strict budget basis, results are expected in definite sales value of the product.

Accessibility of units and wearing parts was an outstanding feature particularly in the design of the latest model. The usual ideas of designing with an eye for convenience of production were subordinated to the needs of the maintenance shops of the operators for units that could be removed and re-assembled with the minimum loss of operating time of the coach. The new model V225 reflects throughout the design the close study that was made of the problems of the bus operators, and the efforts made to provide a product that could be inspected and maintained on the operators' lines with a minimum of labor cost. Objectives sought for in this design, as compared with corresponding models of 1929 and 1930 were: greater comfort, decreased weight, higher power-weight ratio, finer appearance, increased interchangeability of units, greater ease of removing the power plant, longer life, and lower



THIS SUPPORT for front end of engine and radiator facilitates quick removal of the power plant

initial cost to the bus operating company.

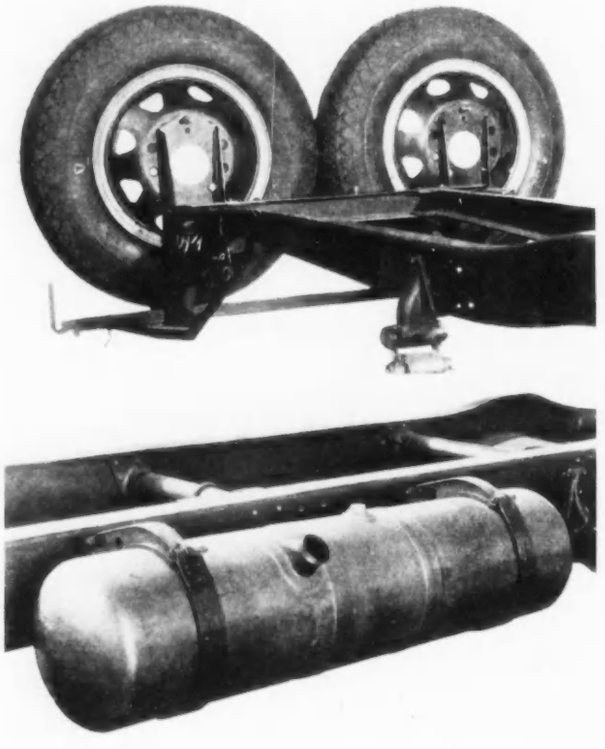
Since the "parlor" or intercity type of body is the one most widely sold, this type will be considered in the description, although city type bodies also are furnished. With this body these coaches are used chiefly in long-haul traffic, running from coast to coast in some cases, and being capable of level road speeds of 50 m.p.h. or more. Ordinarily they seat from 25 to 31 passengers, but folding aisle seats can be furnished to accommodate additional passengers.

Chassis have 225 in. wheelbase and are fitted with either a 468-cu.in. or 525-cu.in. displacement engine. Many engine parts, including the crankcase, are the same. Either of the two sizes of engine can be furnished without change in mounting.

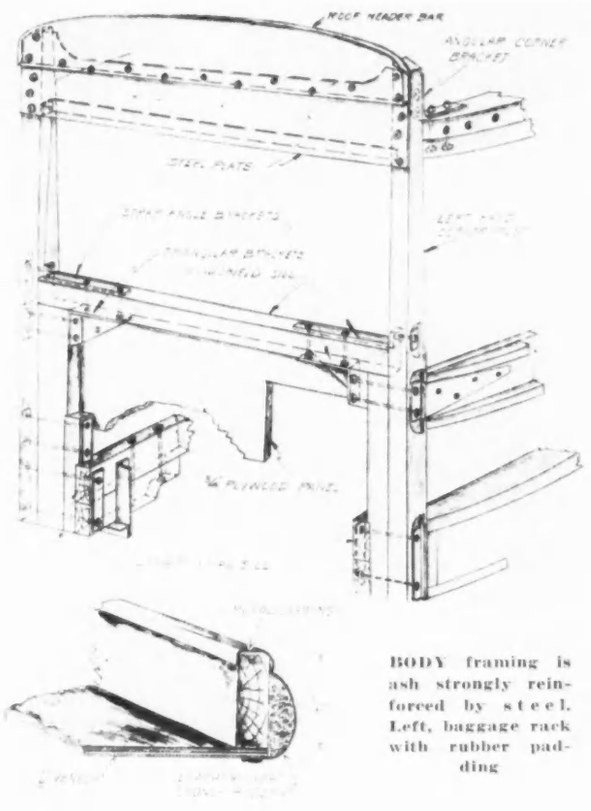
Chassis frames formerly were kicked up over both front and rear axle and side members were not straight in plan view. Some cross-members were tubular, as at present, but were fastened to the side rails by cast steel flanges. In the 1931 model the side rails are parallel in plan and straight in both views, except for a small kick-up over the rear axle, and the four tubular cross-members have forged (or hot pressed) and consequently much lighter flanges welded to them. This construction results in considerable weight saving. It also helps to reduce body cost. Side rails have a maximum depth of 12⅛ in. and the lower flange is bent downward at its inner edge to increase stiffness. Although the frame is slightly higher at the rear than formerly it is no higher at the point of entry. Moreover, since the rear wheel houses cut into the body less, they permit improved seating with correspondingly increased comfort.

A cylindrical sixty-gallon terne plate fuel tank replaces the flat tank formerly used, and also permits of stronger webbed outriggers with a simple strap support for the tank. A second tank can be added readily if needed. Spare wheels with tires are now supported by brackets attached to the frame rather than to the rear of the body, which, being relieved of this load, can be lightened.

A most important improvement is the provision for quick detachment of the power plant, which now can be removed by two men in seven minutes. To make this possible the power plant is supported at the rear on a steel plate bolted between the flywheel housing and the bell housing. This plate is bolted against two angles provided with holes to receive tapered dowel pins. Attached to the supporting plate at each side is a flanged roller, which, when the bolts are removed and the engine moved forward, rests on the main side rails and supports the rear of the engine while it is rolled out of the frame. At the front, the engine rests upon a rubber block supported on one end of a short longitudinal channel, which, in turn, is bolted at its center to an inverted-arch cross-member and at its front end to the supporting bracket for the radiator. This arrangement permits the entire



REAR END of chassis frame showing the integral tire carriers supported independent of the body. Fuel tanks are securely strapped to frame outriggers. Two of the flanged tubular cross members are shown



BODY framing is ash strongly reinforced by steel. Left, baggage rack with rubber padding

power plant, with radiator, to be removed as a unit. The radiator has a one-piece chromium-plated shell of pressed steel with die-cast cap.

Quick-detachable exhaust and fuel connections, air lines, water lines to the Tropic-Aire heater for the body, electric leads, and various controls, and a removable center section of the bumper are provided to facilitate removing the engine. The steering gear, being mounted outside the frame, does not interfere with this operation.

For safety's sake the vanadium steel springs have both main and secondary leaves wrapped around the eyes. Spring brackets are of cast steel and the rear ones for the front springs have a split clamping socket for steel tubes that support the rear ends of front fenders. Alemite fittings are provided wherever lubrication of chassis joints is required.

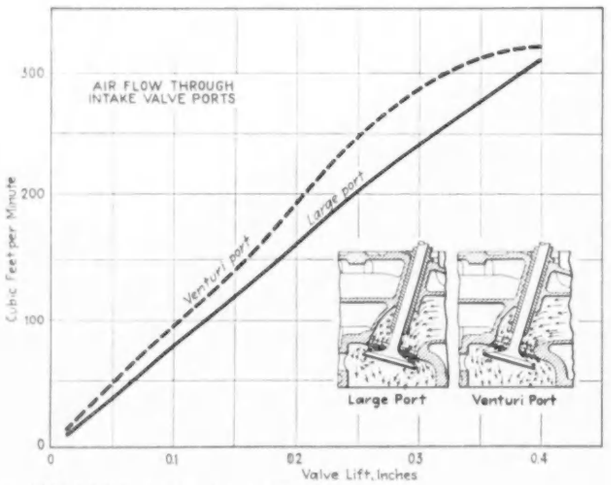
To aid in quiet operation the engine is equipped with hydraulic lash adjusters for the overhead poppet valves. Intake valves are of a standard nickel alloy steel and, although their head diameter has been reduced by $\frac{3}{32}$ in., a change in the intake passage to make an approximate Venturi form has resulted in a larger flow for the same pressure drop. The smaller valves tend to run cooler. The exhaust valves are of Silchrome steel and have a tulip-shape head. Seats for all valves have a 30-deg. angle forming a Venturi passage. The 525-cu.in. engine develops 130 b.hp. at 2,300 r.p.m. Both engines have a $5\frac{1}{2}$-in. stroke, the bores being respectively $4\frac{1}{4}$ and $4\frac{1}{2}$ inches. Crankshafts have seven main bearings and are of heat-treated S.A.E. 1045 steel.

Split-skirt die-cast aluminum alloy pistons facilitate coolings and reduce inertia stresses. Rods are forged from carbon steel, heat-treated to 220-250 Brinell hardness, and drilled for pressure lubrication of pins. Big ends have thin babbitt shells centrifugally cast in the steel.

Cylinder blocks and head are of cast-iron containing 1.5 per cent nickel and 0.5 chromium, an alloy of high wear resistance. Cylinder blocks have 229-241 Brinell hardness. Upper and lower crankcases and inlet manifolds are cast from aluminum alloy to reduce weight. Exhaust manifolds are corrosion-resistant iron castings made in three parts with telescoping joints to compensate for heat expansion. Valve push "rods" are of heat-treated aluminum alloy tubing. The water pump shaft is stainless steel.

A 2 x $\frac{3}{8}$-in. Link-Belt chain with automatic take-up makes a convenient and quiet drive for the camshaft and accessory shafts for the water pump, timer and lighting generator. The fan and the Westinghouse air compressor are arranged for a triangular drive direct from the crankshaft by a double $1\frac{3}{32}$-in. cog-type V-belt, which is quiet, efficient, and easy to adjust. The compressor bearings are lubricated by oil under pressure from the engine pump, thereby avoiding a separate lubricating system which would require added attention. Lubrication of the engine is by pressure feed to main, connecting rod, piston pin and rocker shaft bearings from a double-deck gear pump which first discharges through an oil filter. Between the crankcase and filter, oil passes through a cellular cooler through which water is circulated. On both of the engines two carburetors are used, one for each block of three cylinders. An oil-wetted type air cleaner is fitted and fuel is fed by two A.C. diaphragm pumps.

Other chassis units are more nearly conventional. They include a twin-disk clutch, a four-speed gearset, universal joints with tubular shafting and a rear axle with alloy steel spiral bevel gears, cast steel housing, chrome-molybdenum steel axle shafts, roller bearings and disk wheels. The front axle has a pronounced center drop under the crankcase of the engine. Brake drums on all wheels are made from chrome-nickel cast iron, because of its wear resisting qualities, and have interchangeable air-operated shoes with brake block facings of molded type. Internal hinged-shoe hand brakes operate on a drum next



A SMALLER Venturi-shaped valve port gives greater air flow than a larger conventional port

to the center bearing which supports the propeller shaft about midway between the engine and the rear axle.

Bodies are designed with great care to save weight, insure comfort, reduce maintenance and assure long life. Sills, pillars and top bows are ash with steel reinforcements. No wood except the floor bottom is exposed to the weather, all parts being covered with steel, terneplate or aluminum sheet well-protected against corrosion by a Duco finish and readily replaceable in event of injury. Floors have been lightened by using $\frac{11}{16}$-in. fir tongue and groove flooring, in place of $\frac{7}{8}$-in. yellow pine, and covering it with battleship linoleum.

Panels on the under side of the duck-covered slat roof are made from a light water-proof wood-fiber board with a hard smooth surface which takes a lacquer finish well. The same material forms inner panels below the windows. Above the seats along both sides of the body ply-wood racks covered with carpet carry and prevent chafing of baggage. This ply-wood web stiffens the body transversely. The molding at its inner edge is padded with sponge rubber to prevent injury to passengers should they strike against it.

Pillars are as light as adequate strength permits, but instead of being made wide in a fore-and-aft direction, have their long section axis transverse as this increases window space and makes for better vision. The heater at the front end of the body has a motor-driven fan and a radiator through which engine jacket water is circulated. This helps ventilation, at the same time giving good heat distribution without odor.

All seats are well upholstered to assure comfort. They all face forward and are spaced to give ample leg room. An extra nine inches of effective space is provided by setting the back windows out over a ledge above the spare tires and allowing the tops of sloping seat backs to project into the recess thus formed. Safety through reduced driver fatigue is promoted by making the driver's seat adjustable fore and aft as well as for height. The seat is placed so that control pedals can be recessed into the dash, again saving room for passenger seats as well as placing the driver where he can see to best advantage. Service brakes are air-operated and require very little effort by the operator.

Interiors are finished with lacquer. Fine appearance is enhanced by the chromium plated interior and exterior hardware, radiator shell, and lamps. Exteriors are finished in attractive color combinations. At the rear, plated gates that cover the spare tires, and a sheet metal top extension, striped like an awning, give an appearance resembling that of an observation car. The rear portion of the top is lowered to form a slat baggage deck. The latter has a railing and tarpaulin, and a ladder for reaching this deck is also provided.

THE ENGINEER AND HIS PRODUCT

To evolve a new design, presents as a rule, no serious difficulties, but to develop the design so that it may be commercially produced necessitates infinite patience and skill; in other words, genius. These functions involve a combination of practical and theoretical experience plus manufacturing technique.

The real responsibility of today's successful engineer begins when the drawings and specifications are released to production. He must follow through with production step by step, and he must help solve production problems. He must provide sales with full information concerning the product, its important design elements, its sales factors, its special features, etc. Finally, he must follow through with service, and cooperate in the training of service employees and in the solution of actual field difficulties.

New designs invariably develop weak spots, but these things are as a rule tangible, and remedies may be found as a result of careful study and impartial analysis. But by far the most difficult problems are to be found in the merchandising and distribution of the product. Here scientific training and logic alone are insufficient, for one must take into account a multitude of unknown and variable elements, the most important of which is the human equation.

Engineers must develop their programs well in advance of sales needs. They must keep their product in advance of competition, and obviously it must be designed so that it can be manufactured and sold at a profit.

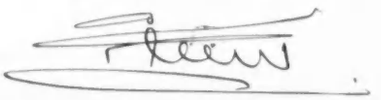
At fixed intervals the engineer must place before the management a clear picture of the proposed engineering policy, briefly and concisely outlining either contemplated changes in current models or additional models, together with estimates covering production and tool costs, the time required for shipments and the point at which it seems desirable that the changes should become effective. This is where the engineer's work actually begins.

It is well to bear in mind that neither new principles nor new designs are developed overnight, and that any successful commercial mechanism represents the efforts of many people over a period of many years. In short, the path leading from the inception of an idea to the distribution of the finished product in which the idea is incorporated is a long and painful one and in many, many cases both the ideas and the men fall by the wayside, never to rise again.

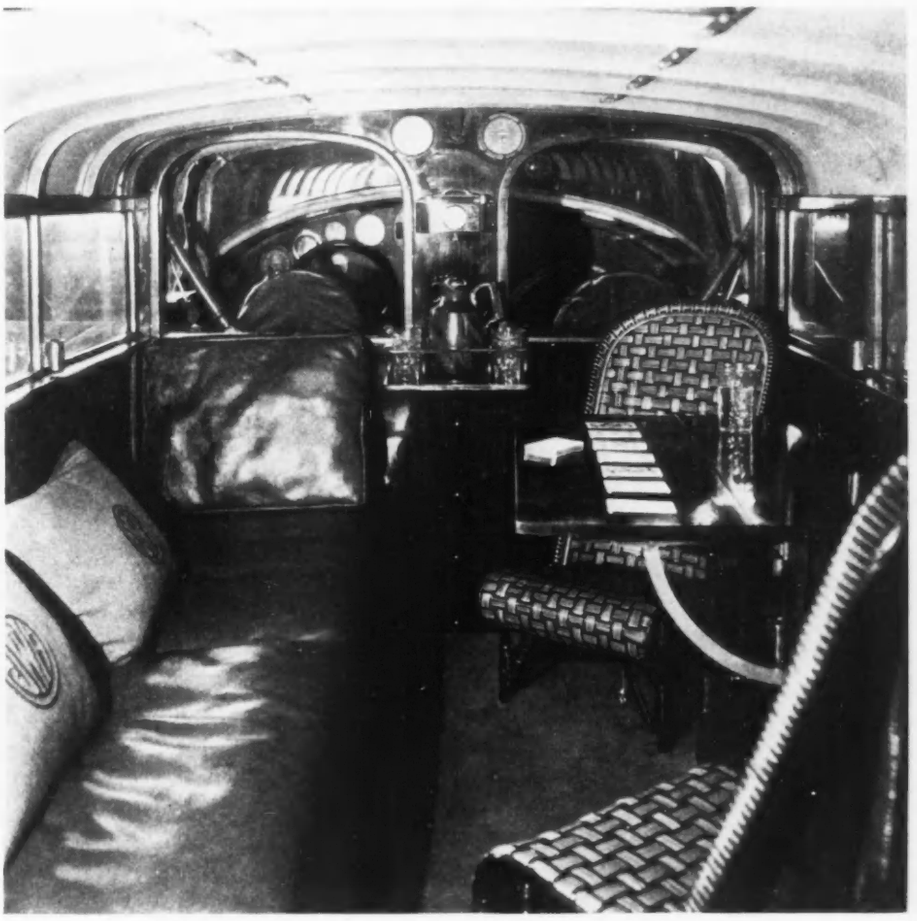
The thing that counts most is experience. It takes a long time to build a good engineering and manufacturing organization, but it takes still longer to build a good distributing organization, including sales and service. We choose our men very carefully and make few changes and since the organization of the Yellow Coach Manufacturing Company more than eight years ago the services of none of our key men have been dispensed with.

We have a tremendous amount of accumulated engineering experience. There are more than 200 engineering employees. Of our key men, 19 have accumulated a total of 380 years of automotive experience, 20 years per man.

In round figures we have in our vaults a total of a million tracings and vendors' vandykes. 500,000 part numbers have been issued. We contact actively with 625 vendors. There exist 4,000 special lists representing modifications to standard bills of materials and there are 5,000 outside bills of material which are represented by 325 vendors.



Vice-president in charge of engineering, General Motors Truck Corporation



Comfort, luxury, safety—all are implied by this Sikorsky "flying yacht" interior, an exceptionally successful job of "consumer engineering" in an important field

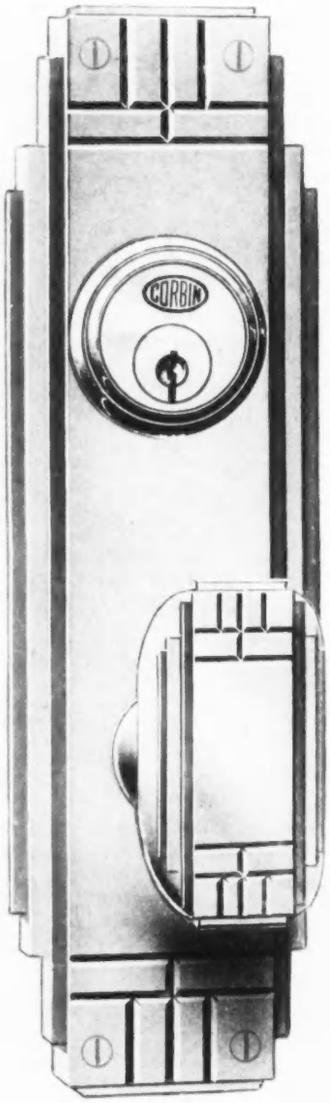
CONSUMER ENGINEERING

being some thoughts on a new conception of product development, and some interviews with outstanding authorities

THERE HAS always existed the function of design relating to the product, but product design as a complete function that not only sees the technical design of the product, but also visualizes it in its entire scope from inception to its place in the hands of the customer, is so new that many designers have not yet grasped its significance. Engineering has always been looked upon as an exact science. But that has led to a danger when it comes to the creation of something that can be sold. The engineer who works close to mechanical details is likely to forget that the buying public has no special interest in his ingenious link motions, in his accurate gear teeth, nor in the type of finish he uses. The public may see only the ultimate end accomplished by the motion. It may only be interested in the lack of noise of the gears, and want appearance and durability in the finish without worrying whether it is enamel, paint, or lacquer. The technical knowledge and the tedious steps by which the engineer has worked out his mechanical problems and selected the best materials for the different parts, so highly interesting to him, may be submerged as far as the customer is concerned.

Sales value is the ultimate end to be sought in any product. From the standpoint of the plant owner the product is valueless if it cannot be sold. Until very recently it has been the sales department that has had to assume entire responsibility for sales. But lately there has been a decided swing in the other direction, and the engineering department is being made to take responsibility when a product does not sell as readily as it should.

Some day someone may coin a new term to express forcibly the meaning of that new subdivision of product development now receiving more and more attention. It is being variously expressed as: styling, consumer engineering, fashion co-ordination, and "package" engineering, the "package" being the form in which the ma-



HARDWARE and interior fittings are being redesigned to provide greater beauty and harmony. New materials and modern design are incorporated in this Corbin knob and escutcheon

A VARIETY of electrical appliances have also been modernized. These lamps, by Nessen Studios, incorporate chromium, formica, parchment, rubber, and glass

chine or other product is marketed to the user. It is the function whose proper execution incorporates into, or adds to, the product those touches of appearance that makes it more acceptable and pleasing to the public.

Opinions of outstanding contemporary American product development consultants and artist-engineers, gleaned from a series of interviews, best express the changing attitude of the user of the products of industry today.

ERNEST ELMO CALKINS

"The profession I designate as 'consumption engineering' is not a fundamentally new idea, it is a new application, a recognition of this phase of product manufacture and distribution as a real field of work. . . . Manufacturers formerly made their products to suit themselves; now they are learning that they must bring their products 'nearer' the user in every element of design, utility, and appearance."

PAUL T. FRANKL

"These new materials are expressive of our own age. They speak in the vernacular of the twentieth century. Theirs is the language of invention, of synthesis. Industrial chemistry today rivals alchemy. Base materials are transmuted into marvels of new beauty."

NORMAN BEL GEDDES

"One of the most notable achievements of the recent alliance of art and industry is the steady decline of pretense in manufactured products. Things are being made these days to look like what they are, with an individual design suited to their function, and are not disguished as something quite different. . . .

"'Modernism' is one of the most loosely and ignorantly used terms today, its meaning confused and misinterpreted in a dozen ways until one seldom knows whether to consider 'modern' a term of praise or contempt. For the majority of people, to describe a room as being decorated in the modern style instantly calls up a lurid picture of angular gadgets on box-like furniture in nursery colors. Such work is simply bad work, which can occur in any age in history, and it is sheer ignorance to believe that it represents good modern design. Freaks are inevitable in any era, but it is not the freaks which live, but the honest creations grounded in the essentials of proportion, color and texture. . . .

"The present century is one of bold experimentation. We are using materials we have never used before; we are employing color in a new way for a new purpose. We should, therefore, expect extremely utilitarian products built on structural lines in a variety of new materials —which is precisely what is occurring in the genuine products of the twentieth century. But we need not expect stark contortions—uncomfortable, badly designed, and highly unreal. This is a practical age which will not tolerate discomfort; it is also an age which demands beauty in its appointments and reality in everything."

LURELLE GUILD

"Engineers should perceive that the advent of the artist in the manner of a 'stylist' for their products is not robbing them of any of the originality of the designs. Rather it gives the engineer who consults the artist an opportunity to add the developed art of centuries to these ingenious mechanical products of the machine age, and produce in them that appearance so necessary in selling and in fitting the products into the normal life of the public."

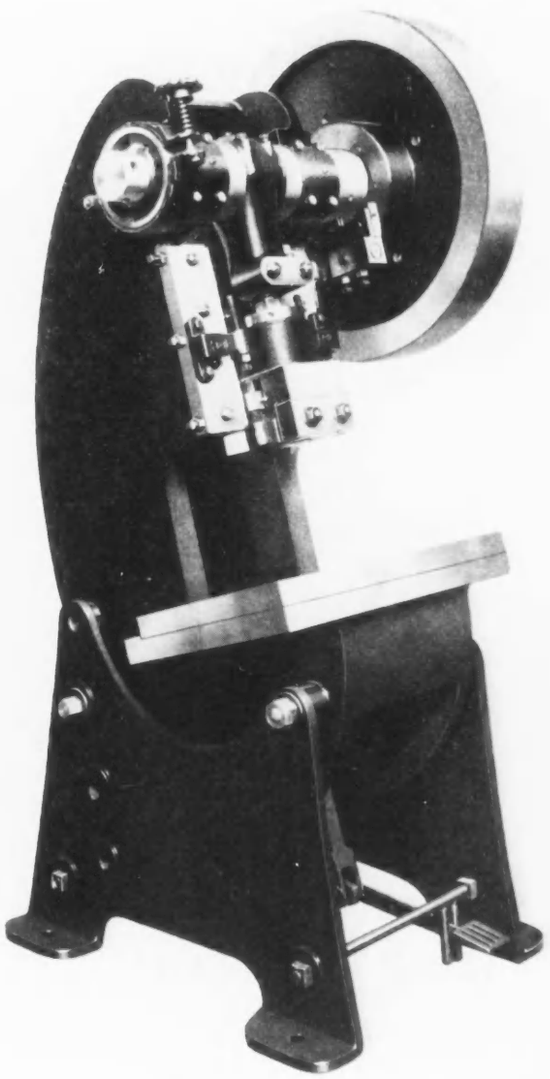
WALTER DORWIN TEAGUE

"'Modernism' got off on the wrong foot in America. . . . But as a matter of fact we have here a foundation for the finest school of design, in a contemporary manner, the world has yet seen, for the reason that we have gone beyond the rest of the world in industrial development, in the application of scientific methods to machine production, in the organization of materials and techniques. The contemporary trend in design demands nothing more startling than mere simple honesty in the use of these advantages, so that the things we make shall be candidly expressive of the materials and methods used in their making, and of the purposes for which they are intended. . . . Any attempt at a mere bizarre effect is a

sin against the modern spirit; which, in fact, demands only that our practical attitude of mind extend its control one step further, beyond the engineering of an article, to the determination of its appearance as well. . . . It is extraordinary how well our products work, and how often they look like Hell."

BEN NASH

"The most important ingredient in today's Product Development recipe is the 'consumer's point of view.' The final answer of success or failure of a new product rests with the consumer's response. New products must not only 'work right' but they must 'look right.' The consumer's education in good looking surroundings require products which have a more artistic organization of the structural elements and are more attractive in outward appearance. We are now living in an era when the artistic visual aspect of products is vital. Mechanical and technical excellence without visual attractiveness cannot compete effectively for the consumer's patronage."



CLEAN-CUT appearance and engineering efficiency make the worker proud of his machine, resulting in lower maintenance costs and increased production. Here is a welded Verson press

WALTER W. KANTACK

"There is inspiring evidence of a world-wide movement to improve the artistic merit of the products of industry, and it is certainly fitting that manufacturers and artists in the United States should waken themselves to the tremendous opportunity presented by American efficiency in production. It is apparent on all sides that the buying public is becoming more discriminating in making its selections and purchases through a greater familiarity with objects of quality and merit. . . . There can be no doubt that through education and better collaboration we shall find ourselves giving expression to definitely American characteristics in our work. The need for thorough fundational work among the neophytes in this field is, however, very great. It is sometimes very depressing to examine work done by those who have not had proper guidance from the start, and who have copied the style and accepted as authoritative the opinions of heads of departments, who have not had proper training themselves. They are proud of their work, and being ignorant of the correct thing, it is difficult to convince them of their error and to undo the faults."

WALTER VON NESSEN

"Three cardinal principles must be followed in art and in engineering. Functionalism—each piece must serve well the purpose for which it is designed; Simplicity—a prime attribute of all good art and design; and Quality—combining the elements of fine craftsmanship and individuality."

RENE CLARKE

"For fifteen years I've seen this styling idea coming closer and closer to a thing that really counts—the low-priced 'package.' That's something to design—a container for the product that millions of hands stretch out to buy because it says something to them that they can't resist!"

EGMONT H. ARENS

"Almost everything which is bought is handled. After the eye, the hand is the first censor to pass upon acceptance, and if the hand's judgment is unfavorable, the prettiest object will not gain the popularity it deserves. On the other hand, merchandise to be pleasing to the hand wins an approval that may never register in the mind, but which will determine additional purchases. The deciding factor in the purchase of an automobile may not be free-wheeling, or accessory gadgets, but the feel of the door handles, the steering wheel, and the upholstery. A typewriter, a fountain pen, a vacuum cleaner, a cigarette case, a compact—their use, and particularly their re-use, are largely determined by their feel in the hand. Probably one of the greatest factors in the popularity of chromium-plated fittings is the unusually 'slick' feel of chromium to the hand."

MAXFIELD PARRISH

"The ugliness of many objects we see around us is frequently blamed on the machine age. The observation is far from true. The machine age is not primarily responsible. True, hand-beaten ware had a certain character about it. But character can also be produced by machinery."

COMMENT AND SUGGESTION

THE COMMENT AND SUGGESTION SECTION is a forum for exchange of opinion. Readers are invited to write letters discussing matters of current interest to development engineers. Articles of a controversial nature, however, will be published only with a bona fide signature.

▼

The Bicycle Paradox

JOHN L. ALDEN
Consulting Engineer

THE accompanying problem in kinematics stumps nine out of ten engineers, first in giving the correct answer, and second in giving the correct proof. In Fig. 1 is shown an ordinary bicycle with a coaster brake. It is at rest, with both wheels firmly in contact with the ground and with the cranks vertical. If a force is applied

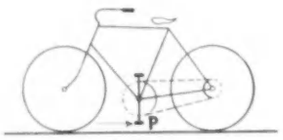


FIG. 1

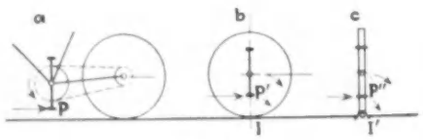


FIG. 2

to the lower pedal P, directed to the rear, in which direction will the bicycle roll, and why?

The bicycle will roll toward the rear, in the direction of application of the force for the following reason: Except for the effect of the sprocket ratio, the wheel and pedals of Fig. 2b are the kinematic equivalent of the rear wheels, sprockets, chain, and cranks of Fig. 2a. Point I is the instantaneous center of rotation of the rolling wheel. Substitute for the latter a single spoke, pivoted at I' and carrying the pedal P'', as in Fig. 2c. This construction is the kinematic equivalent of the wheel of Fig. 2b since the spoke represents that diameter which, at the moment, passes through the point of contact of the rolling wheel and the ground.

It is obvious that a force applied to P'' in the direction of the arrow tends to cause clockwise rotation about I'. A force similarly applied to P' will tend to cause clockwise rotation of the diameter in which P' resides about I. Since there is no slip at I, the result is a true rolling motion of the wheel toward the right.

The doubting Thomas who attempts to demonstrate the fallacy of the foregoing by trial with an actual bicycle will be struck with the unusual sensation of the pedal apparently coming forward in opposition to the hand that pushes it. Motion of the pedal P', with respect to the wheel center, is rotation in the clockwise direction. Its absolute motion, or motion with respect to the earth, follows a cycloidal path. A single word of caution might be advisable in this respect. A forward push on the upper pedal is *not* equivalent to a backward push on the lower. A simple proof of the contention may be obtained by assigning values.

■

STOP... LOOK... LISTEN...

•

SILENCE IS GOLD

DID you ever notice how many radio listeners turn off the excruciating details of film-removing hair tonics and other combinations of adjectives that now monopolize 30 per cent of radio time? Why doesn't some ingenious designer bring out a remote control button that will serve to fade out the two-minute announcements? Or, better still, have an automatic control on the receiver which will cut off the talking and resume when the music starts.

•

GET BUSY!

FLOYD W. PARSONS, in a business article in "Advertising and Selling," warns the stock buyer that no stock is safe enough any more to put away in a vault and be forgotten. He tells them that "new changes and inventions are continually destroying old industries and creating new ones." Quite a compliment to product engineers who are on the job with new ideas! And quite a warning to those who think their "best" product cannot be improved!

•

. . . "EVEN THOUGH VANQUISHED" . . .

LUCRETIUS, many centuries ago, discussed how tools were first made of copper and bronze. But arguments still go on among our wiseacres how it was "impossible" to cut stone with bronze. Recently two Bell Telephone engineers gave some data in a paper on hardened copper that should knock such arguments into a cocked hat. With nickel and silicon in copper, tensile strengths around 130,000 lb. per

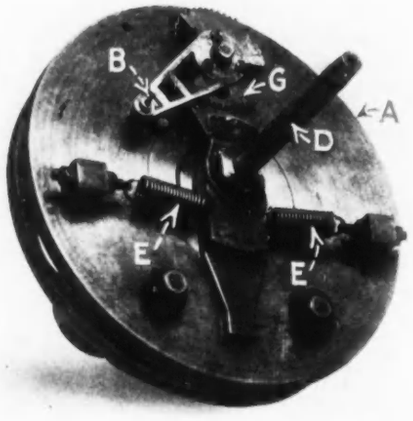
■

Measuring Torsional Vibration Graphically

BY K. O. WITTMANN
Engineer, Berlin, Germany

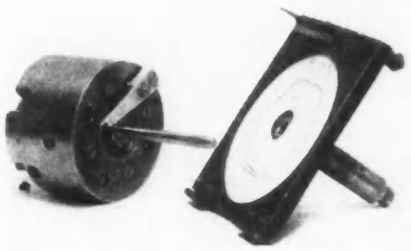
FOR several years the German Junkers company has been developing instruments for measuring torsional vibration of crankshafts. Its latest torsiongraph, shown in an accompanying illustration, is a simple device, designed to measure the relative motion between the shaft subjected to variations in angular velocity and a flywheel rotating at uniform velocity.

In the form of instrument shown



One of the earlier forms of Junkers torsiongraphs

in the lettered figure, the recording arm B is attached to flywheel A. At its end this arm carries a stylus which moves radially a distance proportional to the relative angular displacement between A and the torsionally deflected shaft D. If there is no relative angular displacement the stylus describes a circle, but when relative displacement occurs a wavy line is marked on the polar chart. The latter is carried on a disk which



In this later design, gear sectors are displaced by other motion-transmitting means without backlash

is held by the hand and is slipped over the piloting stem when a record is to be made. The flywheel is carried loosely on a ball-bearing hub attached rigidly to the shaft, the deflection of which is to be measured, and is driven from this hub by the springs E. Relative motion between the shaft and the flywheel, resulting from torsional vibration, is transmitted to the arm B by gear sectors G. In the later form of instrument, also shown, other means without backlash is used to transmit the motion. A special device is used for converting the polar diagrams obtained into others having rectangular coordinates.

Parts of the recorder are given maximum freedom of motion and have an inertia low enough to be capable of recording oscillations having a frequency of 15,000 per min.

■

Simplified Triangle Solution

By H. Greenhalf
Walkerville, Ontario

IN a triangle in which three sides are given, it is customary to use the following formula to determine the angles:

$$\text{Cos } C = \frac{a^2 + b^2 - c^2}{2ab}$$

This is followed by the formula:

$$\text{Sin } B = \frac{b \text{ Sin } C}{c}$$

The following formula requires less arithmetical work, is just as easily remembered, and is suitable for a logarithmic solution if desired:

$$\text{Cos } C = \frac{(a+b+c)(a+b-c)}{2ab} - 1$$

For example: let $a = 2.356$, $b = 2.892$, $c = 4.037$.

By the customary process the designer must find the value of three squares, i.e.:

2.356^2, 2.892^2, 4.037^2.

In the second formula, however, the corresponding calculation takes less than half the time.

■

. . . NOW RUBBER WHEELS . . .

POSSIBILITIES for rubber wheels for railway dining cars are being studied at Issoudon, France, by the principal French railroads. Gasoline-driven engines with rubber tires have been operating for several months, and experts believe that their adaptation for passenger cars will lessen noise, shocks, and deterioration of the rails. News reports fail to mention braking methods, especially for rainy days.

•

INDIUM

LIKE the country newspaper we ought to say: "As we have prophesied in this column"—the first pound of indium has been produced. The Grasselli Chemical Company has the distinction of being the first to extract any quantity of this metal. Now to find uses, and another material for the engineer to think about!

•

TWO DAYS TO EUROPE? . . .

A HUNDRED miles an hour in a motor boat is the record made by Gar Wood in the 12-cylinder Miss America IX. Many a product commercially useful to the public has started as a plaything, and perhaps this sportsman's boat may be the forerunner of a new variety of clipper-ship that will span the seas for those who do not care for the air.

•

. . . "THERE OUGHT TO BE A LAW" . . .

THE Germans put one over on the Allied treaty makers when they designed and built lightweight, "vest pocket" ships by welding and by the use of light alloys. Now the U. S. Navy has followed suit and lopped some thousands of tons each off two new vessels. Oh, for a war or a treaty that would wake the railroad car builders to the possibility of lopping 20,000 pounds off the present design of passenger car! Why not a law limiting the tonnage of dead weight dragged per passenger?

•

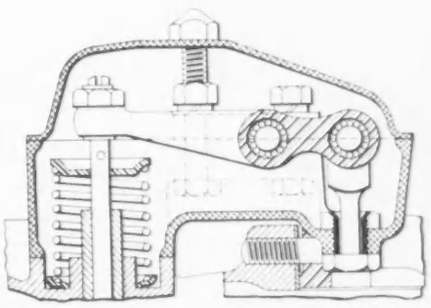
. . . MECHANICAL SMELLING . . .

THREE of the five human senses have been successfully imitated by robots. We now have devices for seeing, hearing, and feeling mechanically, electrically, or chemically. But with robot smelling and tasting we have had but little success. Chemical devices have been developed, but from what source will spring the mechanical units?

An American Needle Bearing

By S. R. Castor
Engineering Department,
H. H. Franklin Manufacturing Company

YOUR item in the April number of *Product Engineering*, referring to foreign practice in the use of so called "needle" bearings, reminds me that a bearing of this same general type was used in the 1914, 1915, and 1916 Franklin cars at the rocker arm pivots, as the accompanying drawing shows. Sixteen rollers of $\frac{3}{32}$-in. diameter and $1\frac{3}{8}$ in. in length were employed in each bearing. The



Rocker arm with needle bearing used on early Franklin engines

clearance, or difference in diameter between the hole in the rocker arm and the pin plus two rollers, totaled 0.0015 to 0.0035 in., or one half of this for each roller. Rollers were made from drill rod hardened in cyanide and the holes in the steel rocker arm were case-hardened. Ends were rounded to $\frac{3}{16}$-in. radius.

Reliable information on service is rather difficult to secure, but a car with this type of bearing owned by one of our shop men is reported to have run upwards of 100,000 miles, and to be in good shape still, never having given any trouble. Since the motion was rocking, and the load all in one direction, the rollers might have indented the rocker arm holes had they not been hardened.

PRODUCT ENGINEERING

Editor: KENNETH H. CONDIT

May, 1931

. . . The research man is never satisfied with what he has done. He is always going on to a greater performance of perfection . . .

—SERGIUS P. GRACE,
Assistant vice-president,
Bell Telephone Laboratories, Inc.

When the New Idea Comes

INVENTING a new machine is not the most difficult of a designer's problems. Once having established a new idea he has two important things to do: determine in detail just what he wants his machine or product to accomplish, and sell the design to the management. His successful solution of the first will depend largely upon his knowledge of the field of sales of the product, and upon his application of that knowledge. Selling the design to the management is the second job, and deserves more thought than appears to be given to it ordinarily.

In many instances progressive managers show great courage and vision in authorizing the expenditure of large sums for the development of a product, sums far in excess of the price realized from the sale of the first machines, such products frequently marking great advances from which all industry benefits. But other managers are not so broad of vision. If a manager is more interested in current operations than in future prosperity he will favor a continuance of the old models until he is forced to change by the inroads of competitors. Then too, a sales manager may be of the type that believes in "high-pressuring" the standard model rather than in pushing a new model, which may cause the sales curve to show a drop for a time. It is this short-sighted policy that has contributed to our present economic difficulty. Long-term planning and far-sightedness are necessities for successful operation of today's business enterprises.

It is in the task of selling the design to the management that the designer can show his ability in applied engineering of a newer type—consumer engineering. His ability to sell the management will depend to a great extent on how well he has studied and absorbed in advance the customers' requirements. This does not mean that he should place himself in the position of forcing over on the shop something that cannot be manufactured economically. On the contrary, every item of the design involving manufacturing methods should have been discussed with the shop executives as the study progressed. It means that the engineer has not let the precise technical requirements of the design overshadow the fact that from the standpoint of the company the machine to be a successful product must sell readily. He must have placed himself without bias in the position of the buyer.

■

No Prosperity Without New Products

PRODUCT development was given first rank in a recent "Survey to Rebuild Prosperity," sponsored by the Sherman Corporation. Of 451 metal fabricators, 288 listed the factor of product development as most important. The vote exceeded, by a wide margin, that for any other factor. In a further survey of 2,304 leaders in all industries, 1,025 listed product development as most important. Contrast these results with Conclusion No. 6 of "Stabilizing Metal Trades Employment," a pamphlet just published by the National Metal Trades Association, which reads, "Encourage and assist every effort toward minimizing unnecessary changes in style or design of products." A careful rereading is essential to catch the word "unnecessary." This is unfortunate, for many readers will miss that one word and assume that product development should be frowned upon in times of stress.

As a matter of record, the experience of companies that have come through major business crises successfully has proved that product development is a vital factor in regaining and maintaining prosperity. Research departments in the

big merchandising houses are unusually active in times like these, initiating research to make products better, more flexible, more salable, and at less cost. The studies of one such concern have caused the development of scores of products, with the result that last year's sales curve shows a much smaller dip than that of many another company not so up-and-doing. The experience of this one company, even unsubstantiated by the evidence of other sales successes described in this number, proves that continual product development is not only necessary, but essential in rebuilding and retaining consumer demand.

■

Look to the Package!

PACKAGING is now being considered a function of the designer. It has been too frequently a matter of "buck passing" to the shipping department, and often an afterthought when the product has been completed. As a result, innumerable cases have arisen where by slight alterations in the design of the product, such as provision for disassembly to eliminate projecting parts, great savings could have been made in size of package, carrying charges, and security during shipment.

The industry of package making, including boxes and cartons, has become specialized, but that does not mean that the designer should consider the package as a thing apart. To be rightly done the package should be developed as a part of the product, with due consideration being given to space saving, weight, strength, and other factors. Important among these other factors is appearance, a necessity when the product must depend partially on eye appeal to win a buyer.

■

What Is Lacking?

MODERN transport plane interiors now give the feeling of comfort and safety. Actually, official statistics for the year 1930 show that there is only one fatality in four million passenger miles, which by comparison makes the everyday automobile look like an automatic machine for the destruction of human life. Yet the upward curve of public acceptance of the airplane as a rapid-transport for passengers has been slight indeed. Is the public lacking in perception, or is the airplane designer overlooking something?

Just after the war it looked as if the airplane industry would be the biggest thing in our mechanical age. Thirteen years have passed, great progress has been made, but the average citizen has not yet the confidence he should have in the air in spite of statistics. One airplane crash discounts millions of miles of safe traveling.

Perhaps improvement in details of the present planes is not all that is required. Perhaps the public is not entirely wrong. At least it knows that navigation of an airplane is largely dependent upon human skill and alertness. The security of the feel of steel rails is lacking. It may be crazy to think of a combination of a helicopter and a standard airplane, but some machine must and will be perfected that will inspire more confidence from the layman, and will also permit vertical landing in restricted space. Is a development of the autogiro going to be the answer?

▼

New Ideas for Old

ISN'T it queer how progress and product development run off some branches of industry just like water off the duck's back? Take as an example the equipment of schools, where we teach progress to our children. Such equipment still remains much as it was when Ben Bolt made eyes at brown-haired Alice at the old mill school. There is the same old chalk, the same old 'raser, the same big boy who sheepishly has to erase the whole blackboard, and the same teacher's pets who hammer the erasers together to clean them. About the only change is that the city school has a janitor who cleans the erasers, sometimes.

Perhaps the manufacturers are waiting for the big boy to rise up in his wrath some day and invent a blackboard with an automatic eraser. Perhaps they say a wiper isn't possible with the present type of marking crayon. It might just occur that a little research would unfold a crayon and a board that would permit marking easily and erasing with a mechanical wiper. Anyway, this is only an example of how some fields of invention remain untouched.

WHAT'S GOING ON—

Trends In Product Design

THE designer of construction equipment has gone further than filling a need for improved machinery—he has created the need itself, according to *Engineering News-Record*. Today, the construction industry cannot afford to neglect the full advantage of his offerings. Several outstanding developments include: Anti-friction ball and roller bearings replace other types at advantageous points. Heat-treated steels and alloy steels have been introduced to eliminate excessive weight and to gain needed strength. Forgings and stampings are replacing castings. Cut-steel gears and enclosed gearing units are now almost standard. Motorization has had a far-reaching effect. Power-controls and easier handled mechanical aids, permit the operator to center his attention on the work.

•

AIRPLANE propellers built just as for airplane use of selected birch laminations enclosed and hermetically sealed in a metal covering, are being produced by the American Propeller Company for cooling men in shops. Balance and tracking are tested as in airplane work, and the propeller has a suitable mounting so that it can be wheeled to any desired location. Fan sizes are from 16-in. diameter handling 2,100 cu.ft. of air per min., with a 1/20-hp. motor, to 48-in. propellers moving 36,000 cu.ft. of air with a 3-hp. motor. The units weigh from 75 to 325 lb.

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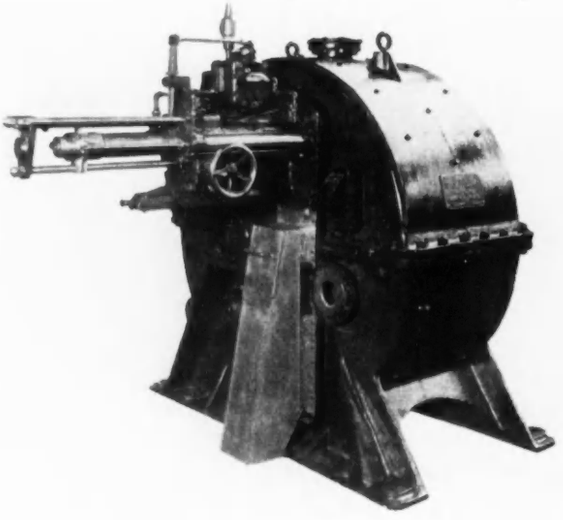

SHARPLES fully automatic horizontal centrifuge with perforated basket. This unit is a salt dehydrator which loads and unloads without stopping, and requires no operator, a distinct design improvement over earlier European designs

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A Glance Over the Pages—

1. *What is an evener motion? p. 203*
2. *What metals have future possibilities for the production of light-weight structures? p. 213*
3. *What sections of a circular ring in tension are stressed most? p. 209*
4. *Why are frame side rails parallel and nearly straight in a recent bus chassis? p. 218*
5. *What is the engineer's relation to the artist? p. 222*
6. *How can a policy for economic production be evolved about a design? p. 220*
7. *Why were aluminum screw-machine parts developed on a large scale? p. 213*
8. *Were "needle" bearings used in American designs and for what purpose? p. 225*
9. *Who received the latest Willans premium for the best engineering paper in five years? p. 233*

•

A NEW DESIGN of elevating grader that has appeared recently eliminates the usual structural frame. The machine is built around a tubular steel backbone mounted on the front and rear axles. The construction virtually eliminates any rackings that formerly resulted when one of the wheels passed over a high bump.

•

A FOUR-CYLINDER, L-head, four cycle design light aircraft engine has been developed by the Continental Aircraft Engine Company. The engine of the horizontal-opposed type, has a $3\frac{1}{8}$-in. bore and a $3\frac{3}{4}$-in. stroke, corresponding to a piston displacement of 115 cu.in., develops 35 hp. at 25 r.p.m., is air-cooled, and weighs 138 lb. with magneto and carburetor. Cylinders are cast in pairs, of nickel iron, with cooling fins cast on them. The heat-treated aluminum alloy cylinder heads are also cast in pairs, with fins in place. Pistons are cast aluminum alloy, as is the crank case. Shafts and connecting rods are carbon steel forgings.

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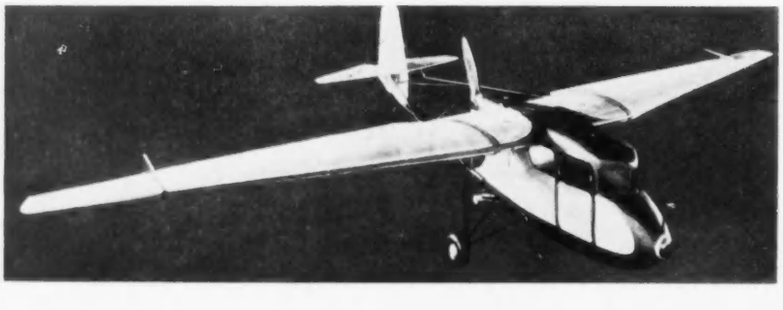
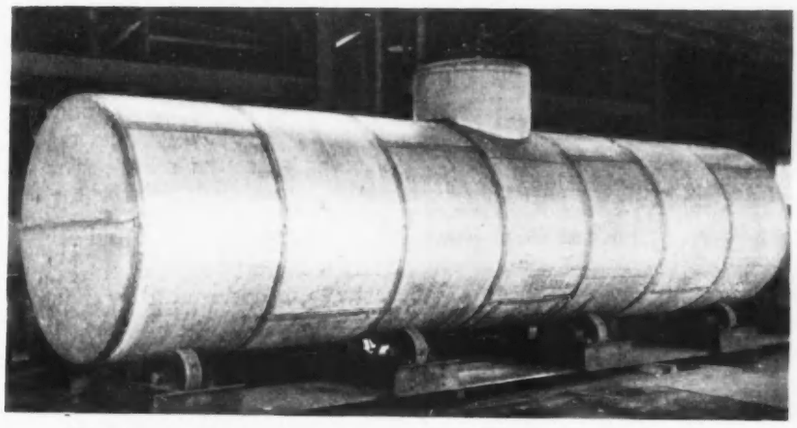


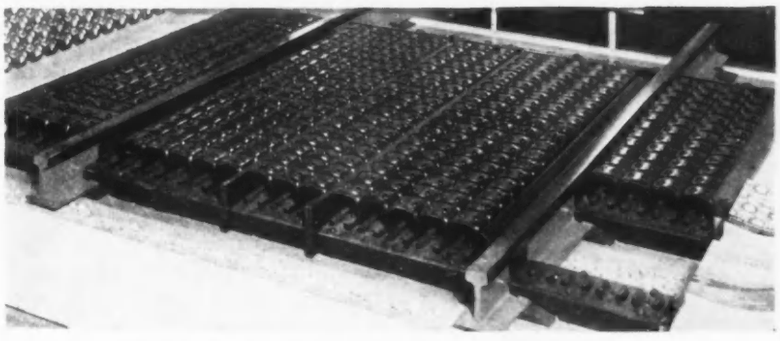
STOUT'S "Sky Car," a small all-metal, two-place cabin monoplane with a Rover pusher-type engine, shown at the Detroit Show

CURTISS controllable-pitch propeller unit assembly, shown at the Detroit Show. Pitch may be altered while the propeller is turning by means of the small flange-mounted electric motor driving bevel gears

REED-PRENTICE 4-way drilling machines employ four horizontal heads. The four spindles are driven by helical gears off drive shafts that connect to a cluster of bevel gears in the bed. Feed is obtained by meshing spur pinions on vertical shafts with steel racks in the spindle bearings. The large central spur gear below the feed shafts receives power indirectly through change gears connected to the spindle drive shaft. All spindles are traversed by means of one handwheel. An adjustable dog, carried on a drum over the rear head, contacts with a plunger for disconnecting the feed.



STAINLESS steel inner tank developed by the General American Tank Car Corporation for use in double-walled cars. The dome is riveted in place after the shell is assembled inside the outer steel tank. The inner tank is held in place by oak blocks and a melted special filler material poured in hot.



HIGHWAY-RAIL crossing, A. O. Smith Corporation. The locking base is made of short sections of channel spiked to the ties and having raised integral ears which hold the horizontal deck channels. The upper surface of the latter have raised non-skid nubbers formed by punching, and are easily slipped into or out of place. Channel-shaped flange-ways are used

NIPPLE FITTINGS for lubricant gun attachment are no longer threaded or the hole tapped to receive them. Such nipples are being made with shanks that are a drive fit in the hole. By using a hollow-ended punch that mates with the nipple, the latter can be driven home with a single hammer blow, thereby saving the cost of threading and tapping and assuring more rapid assembly.

•

REPEATED consumer demand for a kit of parts with which mechanical spring clocks can be electrified has resulted in the production of such a kit by the Hammond Clock Company. The kit includes a complete movement, adjustable mounting brackets for installation in cases of various sizes and design, five sets of hands to accommodate various size dials, and all other necessary parts. It is to retail for around $10 through regular clock distributors.

•

A DUMP WAGON, having an automatic spring wind-up of the dump bottom, appeared recently. The energy of a dumping load winds up a heavy spring, and the doors remain open until a catch is released at the will of the operator. The spring then closes the bottom, automatically dogging them closed. Another type of power wind-up permits the opening of the doors any desired amount to aid in spreading the material.

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IN SPITE of the general depressed condition in industry, one leading manufacturer of ball and roller bearings reports an increase of 20 per cent in sales to manufacturers of construction equipment during the past nine months. Elimination of the necessity for frequent oiling, a matter usually neglected by the user of such machines, is given as one of the greatest reasons for the adoption of anti-friction bearings.

Bucyrus-Erie 200-ton railroad crane

REFINEMENTS in design have occupied manufacturers of oil burning equipment during the past year. This was true of almost all of the 70 or more companies exhibiting at the Eighth Annual Oil Burner Show in Philadelphia, April 13-18. The only change in merchandising policy is the offering of two "single-unit" oil burners. In either case, the design of the boiler or warm-furnace, oil burner, and control apparatus has been considered as a unit. Lower over-all price and better appearance results. Spinner-type oil burners are smaller than ever, trim in appearance, and quiet in operation. A single unit exemplifies the attention to detail generally prevalent. In the largest size, a die-cast spinner plate is now used, instead of pressed alloy steel. In the smaller sizes, the fan can be removed for one of larger capacity if required, diameter being the same. Telescoping legs permit adjustment to the height of the ash pit. Nitralloy steel bearings are employed instead of bronze. Pressure grease fittings make for convenient and positive lubrication. In the gun-type oil burner, one manufacturer uses a white vitreous enamel base, black lacquer, and chromium plating to achieve satisfactory appearance for modern basements. Others use color liberally. Accessories tend to combine all necessary apparatus into one unit, so interlocked as to provide a maximum of safety in operation.

•

A GLASS BUBBLE two ten-thousandths of an inch thick, for use as a window in a tube which produces high-speed electrons, has been developed by Dr. C. M. Slack, Westinghouse research engineer. Forming the end of a Lenard Ray tube, the bubble can, thin as it is, withstand atmospheric pressure. In manufacture, the end of the tube is worked to a definite thickness and the bubble is made by sucking in on the opposite end to make the bubble an integral part of the tube. Although so delicate that touching will destroy them, the tubes are more practical than the metal foil windows hitherto used, are cheaper to manufacture, and can be shipped with less danger of destruction.

LOCKHEED-ORION low-wing sport monoplane in flight, showing landing gear retracted. It is said to be capable of 220 m.p.h. Several unusual design problems were involved in the retractable landing gear

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CENTRIFUGAL box car loaders built by the Stephens-Adamson Manufacturing Company are capable of throwing various dry materials an average distance of 30 ft., yet weigh less than 750 lb. and are operated by one man. The carrying surface of the endless conveyor belt travels at 1,800 to 2,000 f.p.m. Centrifugal action imparts enough speed to the material to cause the throwing. The loader has a capacity of 350 tons per hour. Double-row, self-aligning SKF ball bearings provided with grease seals are used. Each of the eight bearings is fitted with an individual, industrial-type Alemite fitting. The machine is driven by a totally enclosed Westinghouse motor through a Morse silent chain drive.

•

RADIO TYPEWRITERS, demonstrated recently by Glen W. Watson, their inventor, are capable of sending a message typed on a transmitter and having it received in typewritten form at any distance at a theoretical rate of 1,200 letters a minute. The essentials of the mechanism are two automatic revolving contact arms electrically driven and synchronized, each passing in revolution over insulated segments. Each segment of the sending mechanism is connected with a key on the sending typewriter and a similar arrangement is followed at the receiving end. Contacts on the sending segments release short-wave radio impulses through the usual radio apparatus and these impulses are picked up by the receiver and converted into battery impulses strong enough to operate the receiving typewriter.

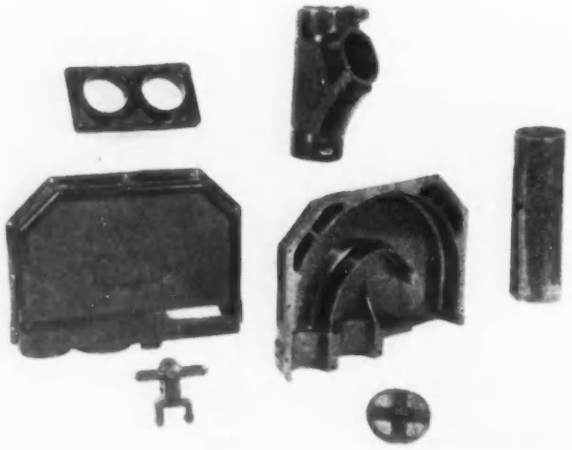
Standards and Specifications

BEGINNING of work on the development of a National Standard Specification for Leather Belting has been approved by the American Standards Association. Work on the project will be undertaken immediately by a technical committee made up of representatives, manufacturers, distributors, large industrial users, and the government.

The proposed American Standard for Chucks and Chuck Jaws has been released in tentative form by a technical committee of the A.S.M.E., and is being distributed to the industry for criticism and comment. The proposal contemplates standardization of chuck diameters, eleven sizes ranging from 6 to 36 in. having been fixed. It gives in tabulated form dimensions for master jaws and removable top jaws, and covers some detailed dimensions of other elements.

Three new tentative standards include Specifications for Refined Wrought-Iron Bars, and for Wrought-Iron Plates, submitted by the A.S.T.M. as sponsor, and Symbols for Heat and Thermodynamics.

After being satisfied that methods are available by which it is practicable to make inspection tests of welds, the



PARTS OF stations of Lamson pneumatic conveying systems are now molded of Bakelite. Several large parts are included, those at the center being about 12 in. wide. Several types of exterior finish are obtained by molding parallel lines or dots into the surface, contrasting them with the ordinary polished surface of the part

Bureau of Engineering of the Navy Department has decided to use electric welding on the main boiler drums of four of its new 10,000-ton cruisers now under construction. It is planned to make an X-ray plate of each inch of the weld and magnetic analysis.

Recent Simplified Practice Recommendations, issued to manufacturers, distributors, and users, include No. 17 on Forged Tools, R60-30 on Packaging of carriage, machine, and lag bolts, R94-30 on Open-Wedge Steel Joists, and R-97-30 on Bell-Bottom Screw Jacks. Federal Specification UU-G-226 on Drawing Paper, a proposed revision of Federal Specification No. 595, has also been distributed, as has proposed revision No. 591 of the Federal Specification for Tracing Cloth. Other proposed revisions include TT-W-261 on Basic-Sulphate White Lead, TT-Z-321 on Dry and Paste Leaded Zinc-Oxide, and F.S. 537 on Cast-Iron Water Pipe.

Engineering Notes

ENGINEERING Societies Library has completed arrangements for the publication of a series of technical treatises, to be known as "Engineering Societies Monographs." They will give in book form those important technical manuscripts which have proved too extensive for publication in the periodicals or proceedings of engineering societies, and of too specialized a character to justify ordinary commercial publication in book form. The first volume projected for the series is "Plasticity," by Dr. A. Nadai of the Westinghouse Research Laboratories.

Included in the technical papers to be read and discussed at the Fifth National Technical Meeting of the Aeronautics Division, A.S.M.E., in Baltimore from May 12 to 14, are "Airplane Metal Developments," "Airplane Designs," "Airplane Engines," "Airship Developments," "Instruments in Piloting," and "General Developments," together with a series of inspection trips to principal airports and aircraft manufacturing companies in the area.

Six papers aside from those on fuels were given for the aircraft engine designer at the S.A.E. Aeronautics Meeting at the Book-Cadillac Hotel, Detroit, April 15 and 16.

Industrial Engineering, one of the McGraw-Hill publications, became *Maintenance Engineering* with the April, 1931, issue.

The first National Meeting of the Applied Mechanics Division, A.S.M.E., to be held at Purdue University, June 15-17, will include an exhibit of new research apparatus and devices in the field of applied mechanics.

The Steel Founders' Society of America, Inc., has established a Development Engineering Department with headquarters at 932 Graybar Bldg., New York, N. Y. The principal function of this division will be to develop new uses or new applications for cast steel, as well as to serve all industry in a consulting capacity with reference to metal construction problems when cast steel can be used.

Five hundred members and guests attended the New England Spring Sectional Meeting at Hartford, April 14, of the A.S.S.T. Technical papers included "The X-Ray in the Metal Industry," "Recent Developments in Nitriding," and "The Metallurgist in Industry."

Included in the papers at the Annual Meeting of the American Welding Society in New York, April 22-25, were "Formulas for Eccentrically Welded Connections," "Some Tests of Gas-Welded Structural Joints," "Welded Machinery Foundations for Ships."

An exhibit of testing apparatus and machines will be sponsored by the A.S.T.M. in connection with the Annual Meeting of the Society at the Hotel Stevens in Chicago, June 22-26. The exhibit has been planned with a view to having a distinctly scientific and broadly educational atmosphere. It is limited to equipment and apparatus used in the testing of materials and products, and recording and control equipment used in testing.

News of the Metal Markets

COPPER was selling during the second week in April at 9½c., delivered in Connecticut. A hearing on copper costs was held in Washington on March 31 before the Tariff Commission, and it is expected that the subject will be discussed at the next session of Congress. Various of the large copper mining companies showed big drops in earnings for 1930.

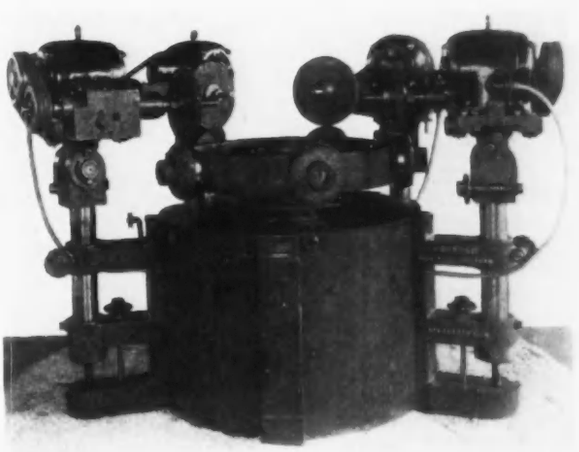
NON-FERROUS metal prices for the first quarter of this year, according to the *Engineering and Mining Journal* weighted index, stood at an average of 67, taking 100 as a composite for the years 1922-3-4. The average for the year 1930 was 82.8, as compared with 110.3 for the year 1929. Improvement in prices is not looked for in the first half of this year.

MANGANESE may be greatly affected by the efforts of the Soviet Government to push exports of Russian ore. A new source has also opened up in South Africa.

TIN stocks were low at the end of March, but prices declined because of the rumor of difficulties in the tin plan. The price, New York, on April 8 was 27.45c.

PALLADIUM, now coming in as a plating metal, is being quoted from $19 to $21 per oz., with platinum at $26 to $28 per oz.

ALUMINUM, in commercial or mill ingot, on April 9, was 23.30 per lb. Nickel shot and ingot was 36c. Monel metal, in finished sheets, was quoted at 42c. Nickel is required in many corrosion-resistant alloys.



Polishing of round, flat, or beveled work is possible on this Hammond automatic polishing and buffing machine. Heads are universal and V-belt driven to eliminate vibration. A Geneva motion indexes the table

IN THE SPOTLIGHT—

EDWARD C. BULLARD, vice-president and director of The Bullard Company, Bridgeport, Conn., has been appointed general manager to succeed his uncle, the late Stanley Hale Bullard. Mr. Bullard is the first of the third generation of the family to assume so important a position in the organization. He became associated with the company in 1917 and was made assistant to his father, DUDLEY B. BULLARD, chief engineer, in 1926. Three years later he was appointed an engineer in charge of design and research and in 1930 vice-president.

HERACLIO ALFARO has become a special representative and consulting engineer of the Autogiro Company of America, Philadelphia. He was formerly owner of H. Alfaro Aeronautical Engineering, Cleveland.

DR. JAMES ASTON, inventor of the Aston process for mechanical puddling of wrought iron, has been made 1931 Chairman of the Pittsburgh Section, A.I.M.E. DR. E. A. HOLBROOK, Pittsburgh University, is vice-chairman.

GEORGE S. BRADY, Manager Editor of *Product Engineering* and Associate Editor of *American Machinist*, led the discussion on "Product Design for Increased Utility and Improved Marketability" at an informal management conference of the Metropolitan Section, A.E.M.E., in the Engineering Societies Building, New York City, on April 3.

GEORGE G. LANDIS, in charge of electrical and mechanical design of motors and arc welders for the Lincoln Electric Company, Cleveland, Ohio, has been made chief engineer. He has been with Lincoln for the last eight years.

FRANK M. BRINKERHOFF has been appointed consulting engineer co-operating with the committee on Research and Freight Car Design of the American Railway Car Institute, 61 Broadway, New York City. Mr. Brinkerhoff has been an associate of L. B. STILLWELL, for 20 years as consulting engineer specializing in car design.

H. E. BROMER, metallurgist of the Standard Foundry Company, Racine, Wis., spoke on "Electrical Furnace Iron and What It Means to the Automotive Engineer" at the March Dinner meeting of the Milwakee Section, S.A.E.

H. R. KRUEGER has been appointed vice-president in charge of engineering of the Ex-Cell-O Aircraft & Tool Corporation, Detroit.

C. R. CADY, formerly foundry engineer for Frank B. Chase, Inc., and now with the engineering department of the National Engineering Company, Chicago, spoke on "The Building of a Large Tractor Foundry in Russia" at the April 2 meeting, Chicago Foundrymen's Club.

LE ROY CHADBOURNE, formerly test engineer for the Wright Aeronautical Corporation, Paterson, N. J., has become a traffic representative for Eastern Air Transport, Inc., Brooklyn, N. Y.

P. A. COLLINS has become an experimental engineer with the Olds Motor Works, Lansing, Mich. He was formerly sales manager of the Detroit office of the Muncie (Ind.) Products Division, General Motors Corporation.

P. S. DICKEY, who for several years has specialized in automatic combustion control for the Bailey Meter Company, Cleveland, is now research engineer.

HENRY B. DIRKS, member for 12 years of the Engineering Department, Michigan State College, East Lansing, Mich., has been appointed dean.

Edward C. Bullard

●

George G. Landis

●

H. R. Krueger

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HARRINGTON EMERSON, founder of the Emerson Engineers, 30 Church St., New York, N. Y., was recently presented with a certificate of honorary membership in the Masaryk Academy of Czechoslovakia at a luncheon in his honor at the Engineers Club, New York. Dr. Jaroslav Novak, Consul General of Czechoslovakia in New York, made the presentation.

S. E. DONOHUE, formerly an engineer with the A. L. Powell Power Company, Oak Park, Ill., has joined the John Deere Wagon Works, Moline, Ill.

B. P. COULSON, JR., and H. N. HACKETT of the General Electric Company, Schenectady, N. Y., spoke on "Design, Construction and Operation of Mercury-Vapor Generating Units" at the March 24 meeting of the Philadelphia Local Section, A.S.M.E.

DR. P. V. SARAGHER of the Aluminum Company of America, spoke on "The Structural Applications of New Aluminum Alloys" at the March 26 meeting of the Waterbury Local Section, A.S.M.E.

A. C. HAMILTON, formerly vice-president and chief engineer of the Issoudun Aircraft & Manufacturing Corporation, Northville, Mich., has become an aeronautic engineer with the Automotive Fan & Bearing Co., Jackson, Mich.

BENJAMIN G. HARMON has been elected vice-president of the Gas Machinery Company, Cleveland, in charge of the newly-organized furnace engineering division.

NEWTON S. HOERLE, formerly an engineer at the Muskegon, Mich., plant of the Continental Motors Corporation, has become automobile and engine production engineer for the Automobile & Tractor Corporation of the U. S. S. R., at Moscow, Russia.

THOMAS HOLLOWAY, formerly with the Farrel Foundry & Machine Company at Buffalo, N. Y., has joined the United Engineering & Foundry Company, Pittsburgh, as gear consultant.

M. R. HUTCHINSON, JR., has become an engineer with the Packard Motor Car Company, Detroit.

WALTER C. KEYS, for the last four years manager of automotive development in the Mechanical Rubber Division, United States Rubber Company, Detroit, has resigned to open an office of his own in the Stephenson Building, Detroit, where he will pursue automotive engineering and sales work.

LEWIS G. LINDEMUTH, consulting engineer, has been appointed vice-president and general manager of the Marine Steel Corporation, New York. The company is developing corrosion-resistant alloy steels for marine application.

PROF. L. C. LICHTY of Yale University, spoke on "Internal Combustion Engines" at the April 24 meeting of the New Haven Local Section, A.S.M.E.

THOMAS J. LITLE, JR., consulting engineer of Detroit, has been elected vice-president and director of the Holley Carburetor Company, in addition to his consulting practice.

DR. M. LUCKIESH, director of the Nela Park Lighting Research Laboratory of the General Electric Company, Cleveland, Ohio, has been awarded a fellowship in the Distinguished Service Foundation of Optometry.

JOHN A. MAIR has been appointed field engineer of the Buffalo plant of the Worthington Pump & Machinery Corporation, Harrison, N. J.

RUDOLF MANGOLD, formerly chief draftsman of the Robert Bosch Magneto Company, has become assistant to the vice-president of the newly formed United American Bosch Corporation, formed by the merger of the Robert Bosch Magneto Company and the American Bosch Magneto Corporation.

FRANCIS HODGKINSON, consulting engineer of the Westinghouse Electric & Manufacturing Compay, East Pittsburgh, Pa., has received the Willans Premium, outstanding British engineering honor, for the paper on "Journal Bearing Practice" published by the Institution of Mechanical Engineers of London. He is an authority on steam turbines and marine machinery.

C. D. MCCALL, formerly manager of Manning, Maxwell & Moore, Inc., Detroit, Mich., has taken charge of the engineering and sales office of the Muncie Products Division, General Motors Corporation.

STANLEY H. MCKEE, formerly chief engineer of the Republic Steel Corporation, Youngstown, Ohio, and C. G. JONES, formerly identified with the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., have been made special engineers by the Youngstown Sheet & Tube Company.

IGOR SIKORSKY, founder of the Sikorsky Aviation Corporation, will speak on "A Novel Method of Studying Flying Boat Hull Models" at the S.A.E. Aeronautic Meeting.

J. W. MILLS has resigned his directorship of the Kelsey-Hayes Wheel Company, Ltd., London, England, and has taken charge of the experimental engineering department of Humber, Ltd., Coventry, England.

J. L. MORGAN has resigned as experimental engineer with the Auburn (Ind.) Automobile Company, and has become an engineer with the Jamestown (N. Y.) Metal Equipment Company.

CHARLES E. STUART, president and treasurer of the Tyson Roller Bearing Corporation, Massillon, Ohio, is the inventor of a new bearing known as the "Cageless Tapered Roller."

CHARLES NELSON, JR., formerly chief draftsman with the Strom Bearing Company, Chicago, has become a tool designer with the Ahlberg Bearing Company, also of Chicago.

GERALD TAYLOR WHITE, editor of *Motor Boat*, New York City, has resigned to open the Westlawn School of Home Study, Montville, N. J., to conduct a correspondence course in boat designing. He will also continue the work of personally designing boats and writing technical papers on boat designing and marine engineering.

F. G. PARNELL, formerly designer on cars with the Triumph Motor Company, Ltd., Coventry, England, has joined the Humber - Hillman - Comer Combine Company of Coventry, as chief designer in the light-car section.

W. W. NICHOLS, vice-president and mechanical engineer of D. P. Brown & Company, 1440 Park Place, Detroit, Mich., and PROF. F. G. NOVY were decorated with the Order of the White Lion by Dr. Ferdinand Veverka, Czechoslovak Minister to Washington, on April 13. Mr. Nichols has done considerable development work on belt drives and has been an active committee member in the A.S.M.E. and S.A.E.

Francis Hodgkinson

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Igor Sikorsky

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Charles E. Stuart

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CARL D. PETERSON, formerly chief engineer with the Brown-Lipe Gear Company, Syracuse, N. Y., has joined the Spicer Manufacturing Company, Toledo, Ohio, as an executive engineer.

J. P. POWELL, assistant engineer of the General Electric Company, spoke on "Photo-Electric Cells and Their Application to Machine Control" at the April 23 meeting of the Waterbury Local Section, A.S.M.E.

WILLIAM G. PRAED has been appointed radiograph engineer in charge of the new commercial X-ray Laboratory at 2416 West 15th Place, Chicago, Ill., of the Claud S. Gordon Company, 708-714 West Madison St., Chicago.

C. I. PRESTON, formerly chief engineer of the Lambert Aircraft Engine Corporation, Moline, Ill., has become a research engineer with the Lawrance Engineering & Research Corporation, New York City.

J. OTTO SCHERER has severed his connection with the Junkers Corporation of America, and is now in the independent field as a consulting engineer in Detroit.

F. J. SCHLINK, Assistant Secretary of the American Standards Association, resigned recently to become full-time technical director of Consumers Research Inc., New York City.

HARRY A. SCHWARTZ, formerly research engineer for permanent-mold development, with the American Foundry Equipment Company, New York City, has become general manager of the Montpelier (Ohio) Mfg. Co.

CLIFFORD W. SMITH, formerly a body layout man for the H. H. Franklin Manufacturing Company, Syracuse, N. Y., has become a designer with the International Motor Co., Allentown, Pa.

EARL H. SMITH, formerly experimental engineer for Oldsmobile, has jointed the Oakland Motors staff in an engineering capacity. He joined Oldsmobile in 1925 as an inspector and became experimental engineer in 1927.

JOHN D. TYSON, formerly assistant metallurgical engineer of the Standard Steel Works Company, Burnham, Pa., has been appointed chief metallurgist.

R. MASSON WEBSTER, JR., has joined the International Motor Company, Allentown, Pa., as a draftsman, having resigned from the American Die & Tool Company, Reading, Pa.

Obituaries

EDWARD DWIGHT PRIEST, 70, veteran designing engineer in the Railway department of the General Electric Company, Schenectady, N. Y., and chairman of the board of the Parker Wire Goods Company, Worcester, Mass., died in Schenectady, March 26.

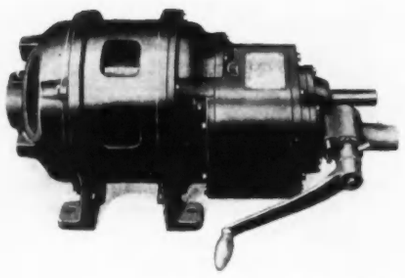
STANLEY HALE BULLARD, 54, vice-president of the Bullard Machine Tool Company, Bridgeport, Conn., died March 22 at Bridgeport after an illness of some months. He was also vice-president of the Bullard Engineering Works, Inc.

NEW MATERIALS AND PARTS AND ENGINEERING EQUIPMENT

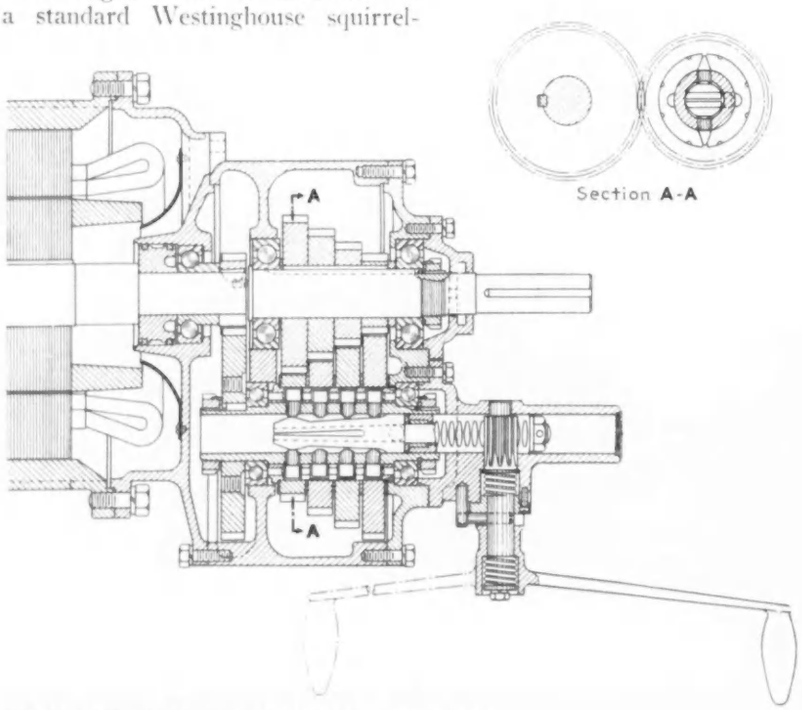
Westinghouse-Wise Multi-Speed Drive

A MULTI-SPEED reduction gear unit built in combination with a standard a.c. motor has been developed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Constructed to give four different speeds to the output shaft at constant horsepower, this unit is known as the "Westinghouse - Wise Multi - Speed Drive." With this drive the speed of the driven apparatus may be changed instantly while the motor is running at full speed and under full load. All gears are constantly in mesh, and in no way can the operator injure the unit by changing speeds at any time, because of smooth pick-up.

This gear unit is mounted on a standard Westinghouse squirrel-cage induction motor. In the gear unit, a pinion mounted on the motor shaft drives a gear mounted on the countershaft. Also on the countershaft are four idling ring gears which are constantly in mesh with four gears that are pressed on the output shaft. Each of the countershaft gears is provided with an internal clutch which is made to fit the bore of the gear. The clutch is actuated by two tapered wedges which are forced between the clutch halves by a spring member. To bring this member to the correct position for a desired speed, the control handle, which is provided with a spur pinion, is rotated, actuating a rack which is mounted on the spring member. This movement brings the spring member between the tapered wedges, thereby providing the pressure for clutching any one of the four ring gears to the countershaft, which in turn drives the output shaft at the desired speed.



By means of the handle any one of four speeds can be selected while the unit is driving or at rest



Gears are always in mesh in the Multi-Speed drive. The section A-A illustrates how the selected driving gear is clutched to the shaft by means of the wedges actuated by the expanding member

Between speed steps are neutral positions. To disengage the clutch and bring it into a neutral position, it is only necessary to rotate the handle to draw the spring member into a position which does not contact the expanding wedges. A further movement of the handle brings the spring member into contact with the next set of expanding wedges, and clutches the next gear to the countershaft. Therefore, it is not only possible to make speed changes under full load, but the apparatus can be stopped or started under that condition.

Ball bearings are used in both motor and gear unit, assuring alignment of the shafts. The gearing in the first reduction, or drive from the motor to the countershaft, is of the single helical type, insuring quietness of operation, and the other gears on the countershaft and those on the output shaft are of the spur type. All gearing is heat-treated. A splash system is provided for lubricating both the gearing and the bearings. An oil gage is provided for checking the oil level.

Because the motor and gear drive

are built as one unit, installation is simplified, less space is required, and only one mounting bracket or foundation is needed, since this unit is applied exactly like any motor.

Applications for a multi-speed industrial drive are many. It is particularly adaptable to machines on which pieces of both large and small diameters are turned. When the quantity of material to be delivered by a conveyor varies, the conveyor drive should be variable in speed. Wood-working tools also very often call for variable or multiple speeds. The drive is offered in three units, ranging in rating from ½ to 7½ hp.

Foeppl-Heydekampf Static and Dynamic Bending Machine

A bending machine for static and repeated reversed loads has been placed on the market in this country by the Southwark Foundry & Machine Company, Testing Equipment Division, Philadelphia, Pa. This machine is known as the "Foeppl-Heydekampf" and is built in Germany. It is especially suitable for short-time determinations of the fatigue limit of materials for machine parts. The features are as follows: Simplicity of construction; no moving parts to wear out; easy operation; simple shape of specimen; versatility of measurements; the results may be checked; clamping effect is eliminated, and quiet operation.

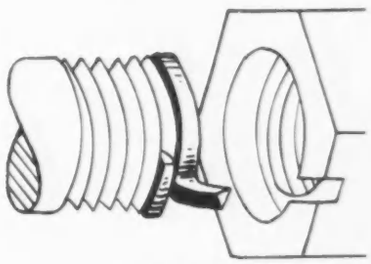
In the lower part of the frame is built a switch panel containing all necessary operating and controlling instruments. Connection of the set to a 110- or 220-volt d.c. source makes it ready for operation. The bottom of the specimen is rigidly clamped to the frame and the top is connected with an oscillating mass of considerable length. Usually the tests are run with two specimens at once. Two blade springs are mounted in a manner similar to the specimens, but they are not intended to break, being thinner than the specimens. The springs, the specimens, and the oscillating mass form a mechanical swinging system, which is excited by two pairs of electromagnets, alternatively giving impulses to the mass. The magnets are switched on and off by a special lever contact device. The switch lever is moved by the mass due to friction, so that the number of impulses agrees with the natural frequency of the oscillating system. Amplitude of the oscillation is varied by changing the current value in the electromagnets.

Amplitude of vibration can be read from the special visual reading devices attached to the ends of the mass. Both devices give the same reading, checking each other. The stress in the specimens is proportional to the amplitude within the range of Hooke's law. If Hooke's law is exceeded, the exact determination of the stress has to be done by the additional static loading arrangement furnished with the machine.

The number of cycles per minute is counted by an electric counter driven by a small synchronous motor in series with the pulsating current line feeding the electromagnets. An adjustable automatic contact mechanism stops the machine after a failure.

"Safety Nut" Brake Lock Nut

Another type of safety nut has been introduced by the Safety Nut Corporation, Land Title Bldg., Philadelphia, Pa., in the form of the "brake lock" nut. This complements the line of "pin-nut" type safety nuts described on p. 92, Vol. 2. Whereas the pin-nut type is made for the insertion of a formed pin to hold the nut precisely at the location desired, the "brake lock" type is provided with a formed brake lock band that permits the nut to be screwed down easily but resists backing off through the action of vibration. The nut has a small aperture at the bottom, in which the end of the brake lock band is inserted and held. As shown, the brake lock band is lying expanded on the first thread of the bolt with the handle raised to meet the descending groove or aperture provided in the nut. Once the handle is seated in the groove, the brake lock band will not slip from position when applying



Spring steel brake lock band on screw ready for engagement with the Brake Lock Nut

or removing the nut. As soon as the nut is given the slightest turn on the bolt thread, the brake lock band, cocked in an expanded position, slips and commences a spiral descent, while firmly hugging the sides of the thread. Just so long as the nut is advanced, there is no resistance, but when an effort is made to withdraw the nut the expanding brake lock band of spring steel sets up a resistance which requires a wrench to overcome.

These brake lock bands and brake lock nuts can be made in any desired thread form in any shape, finish, size or material.

"Codite" Thermoplastic Compound

Dielectric strength twice as great as that of vulcanized fibre is one of the principal features of "Codite," a thermoplastic compound developed by the Continental - Diamond Fibre Company, Newark, Delaware. The dielectric strength is 523 volts per mil for tubing 5/16 in. in internal diameter by 13/32 in. in outside diameter. It is increased to 710 volts per mil for tubing 5/16 in. in internal diameter by ⅜ in. in outside diameter. In hygroscopicity, "Codite" is not superior to vulcanized fibre. A moisture content of from 3 to 6 per cent is conducive to flexibility under heat, although satisfactory results may be obtained with the material dry. The material does not have to be moistened with wet steam before forming, such as is usually done on the forming of vulcanized fibre.

"Codite" is a hard, tough, horny, somewhat translucent, and also some-

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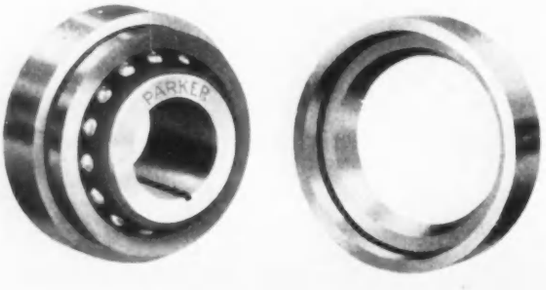
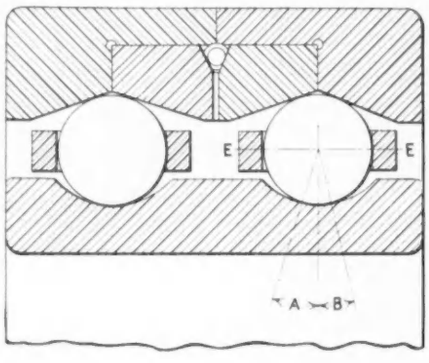
what thermoplastic material. It can be machined easily and accurately and its surface is capable of taking a high polish. It has the property of flowing under pressure as in a die. Extruded washers, for example, have been fabricated with a shank measuring 0.070 in. and a flange of only 0.023 in. Tubes may be expanded in diameter or spun or pressed in a heated die. In the case of sheets, strips 0.050-in. thick may be rolled down safely to 0.028 in. in thickness. Such strips under heat may be bent double without cracking. The material sets in whatever form it is molded and does not become brittle or warp appreciably.

Parker "Hi-Speed" Ball Bearings

Four-point contact of the balls on the raceways is a feature of the Parker "Hi-Speed" ball bearings which have been redesigned by the Majestic Tool & Manufacturing Company, Detroit, Mich. These bearings are built especially for use with internal grinding spindles and are made in only eight sizes. To eliminate crushing of the oil film, which is usually the principal cause of overheating while operating at high speed, the four-point contact design has been evolved. From the sectional drawing, angle *A* is greater than angle *B*, and thus causes the contact point of the ball, on one side of the race, to be farther from the axis of rotation than on the other side of the race. This additional feature causes the ball to rotate in a slightly spiral direction, bringing the entire surface in contact with the raceways. Wearing of tracks or flat spots on the balls is thus eliminated.

These "Hi-Speed" ball bearings are built in eight sizes with bores of 0.375 to 1.625 in., over-all diameters of 1.125 to 3.4375 in., and thicknesses from 0.750 to 1.625 in.



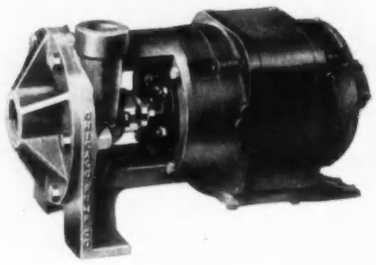


Cross-sectional and disassembled views of the Parker "Hi-Speed" Ball Bearing. Spiral rotation of the balls is induced by making angle *A* greater than angle *B*

Chicago N-Type Pumps

The compact, close-coupled, motor-driven N-Type pumps made by the Chicago Pump Company, 2336 Wolfram St., Chicago, Ill., are intended for hot or cold water circulation, brine circulation, water supply and booster service, washing machines, fountains, and tankless water systems. They can be operated with 200 lb. per sq.in. on the suction side.

N-Type pumps are of the centrifugal type with a non-shrouded bronze impeller keyed to its shaft and held by a nut and locknut. The

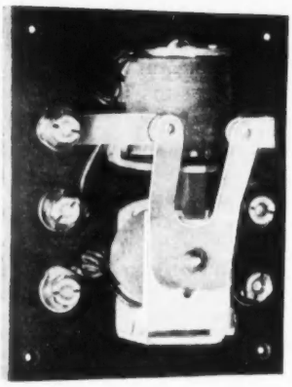


stainless steel impeller shaft is an extension of the ball-bearing motor shaft. When a suction lift up to 15 ft. is encountered, a water seal is provided on the stuffing box, inside connected for clean water and outside connected for gritty water. An extra deep stuffing box is provided to take care of high pressures, and the gland is split to make repacking easy. The semi-steel pump casing is bolted directly to the motor end bell, making a unit construction with 3-point support, there being but one foot for the motor.

With a 1,720-r.p.m. motor and a suction pipe $1\frac{1}{2}$ in. in diameter, a range of capacities from 3 to 50 g.p.m. is available, with discharge heads varying from 22 to 6 ft. With a 3,500-r.p.m. motor the capacities range up to 60 g.p.m. and the permissable discharge heads up to 80 ft. The motors range from $\frac{1}{4}$ to 2 horsepower.

"Dunco" Relay for Thermostatic Control

Universal application to either a.c. or d.c. circuits is a primary feature of the "Dunco" relay for thermostatic control announced by Struthers Dunn Inc., 146 N. Juniper St., Philadelphia, Pa. It can be used on all voltages and cycles by means of shunting out the coil when the contacts are closed and held in position by the mechanical latch. The unit is



"Dunco" Type CS449 Single-Pole Relay for Thermostatic Control

primarily designed to be operated from any three-point control or a start and stop push-button. It has applications for equipment where the heating elements must be shut off and turned on in accordance with temperature variations.

The Type CS449 single-pole relay is illustrated. A Type CS450 double-pole unit is also manufactured. The relay contacts open and close at a speed of 0.01 sec. on d.c. circuits or $\frac{1}{2}$ cycle on a.c. circuits. The same coil winding is used for either a.c. or d.c. requirements, and the device cannot hum or chatter as the coil is not on the line and the contacts are locked in place. The

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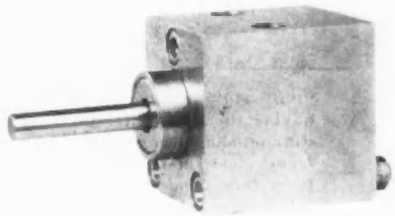
thermostat contacts handle 1/10 amp. at 110 volts, 60 cycles, for a momentary period. These contacts make but never break the circuit. They are all on the same side of the line, and consequently there is little danger of a voltage break-down between the parts of the thermostat itself.

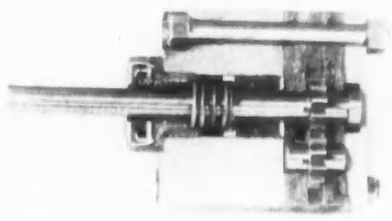
These relays meet with the Underwriters' approval and are rated at 30 amp., 60 cycles, 110 volts; or 20 amp., 220 volts, 60 cycles. They can be used in conjunction with a clock.

"Northern" Nitralloy-Steel Pumps

For service in pumping lubricating oils up to pressures of 1,000 lb. per sq.in. and fuel oils at lower pressures, the Northern Pump Company, Minneapolis, Minn., has developed a line of Nitralloy steel pumps. This alloy is employed for all working parts, because it is highly resistant to the action of acids commonly found in fuel oil and other oils, and because



"Northern" Nitralloy-Steel Pump having all working parts of this wear-resisting steel



Cutaway view showing the Nitralloy steel plates forming the pump chamber

of its extreme hardness it is not scratched when foreign matter is present in the liquid.

As noted in the accompanying cutaway view, the Nitralloy steel shaft is hardened and ground. A bearing nut centers the shaft for the end mounting, and oil is prevented from leaking out by means of an oil retainer. The spring provides for automatic packing adjustment. The pump body itself is made of solid steel to prevent distortion from pipe strain. It can be drilled and tapped to permit mounting the pump in any position. Surrounding the gears are three plates of Nitralloy steel. Beyond them on the end of the shaft is a Nitralloy collar which takes the thrust. The entire assembly is held together by means of three, large fitted dowels. Pumps of this design are built in capacities from 0.55 gal. per min. at 1,800 r.p.m. and 25 lb. per sq.in. and up. They are made in two series. The first is intended for fuel oil, kerosene, gasoline, and lubricating oil. The second series is intended for lubricating oil and any other liquid.

Bunting Hard-Bronze Bearings

BUSHINGS and bearings made of a hard low-friction, phosphor-bronze alloy are announced by The Bunting Brass & Bronze Company, Toledo, Ohio. These products are offered for applications where hardness and ability to withstand pounding are particularly essential, together with the low friction and minimum wear assured by a leaded phosphor-bronze alloy. The lead content may vary from 5 to 25 per cent, depending upon the type of service required.

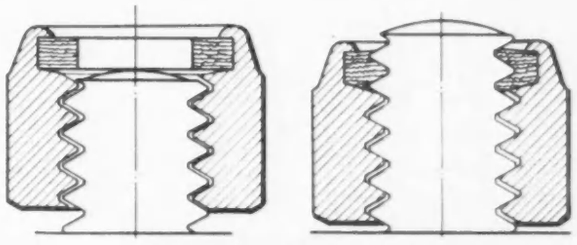
"Elastic" Stop Nuts—*Correction*

A misleading and inaccurate statement was made in the original description of the "Elastic" stop nut, on page 92 of the March number. It was incorrectly stated that this nut for screws subject to vibration can be used only at loads up to the capacity of the fiber. On the contrary, the Elastic stop nut has the same capacity as any standard nut. It differs from a standard nut only in that the height has been increased to accommodate the fiber ring employed to prevent backing off through vibration. The height corresponds approximately to the height of a standard nut plus the thickness of a lockwasher. The threads are standard with respect to height, form, pitch, and fit.

As shown by the accompanying illustration, the hole in the fiber ring is smaller than the diameter of the bolt. Therefore, the ring resists passage of the bolt and causes the thread flanks of the bolt and nut to be pressed tightly together. This pressure occurs on the underside of the bolt threads; the same side that carries the load. Thus, all play between the bolt and the nut is removed. When the pressure of the bolt on the fiber ring exceeds the maximum, the bolt impresses its threads on the fiber ring but does not cut out chips. Considerable friction is developed and is further increased when the bolt is drawn home. The extra friction developed prevents any tendency for vibration to loosen the nut. The elastic nature of the fiber permits the fiber ring to contract and move down when the bolt is removed. The nut locks on new, worn, and undersized bolts.

The air-tight fit of the Elastic stop nut prevents moisture from getting past the fiber ring, and consequently this feature, besides the vibration-proof feature, is of value in electrical connections. A good connection also results from the pressure on the thread flanks. The device can also be employed on spring mountings, rubber insulated and cushion mountings, aircraft propeller shafts, and flexible couplings, to mention a few where vibration is particularly severe.

The Elastic stop nut is manufactured by the A. G. A. Company, Elizabeth, N. J., in sizes from No. 4-48 up to 2½ in., in such materials as steel, duralumin, brass, bronze, Monel metal, and other metals. It is made in any standard thread system and is capable of repeated removal without injury to itself or the threads of the bolt. Furthermore, it is adjustable to any position along the screw.



Left—Bolt at the point of entering the fiber ring. Right—Showing how the fiber ring is pushed upward and thread impressed in it besides pressing the thread flanks together

NEW MATERIALS AND PARTS

"Robins-Jones" Oil-Circulating Bearing

Automatic circulation of the oil from a well in the base of the bearing, around the shaft, and back to the well again is provided in the Robins-Jones bearing manufactured and sold by the Robins Conveying Belt Company, 15 Park Row, New York, N. Y.

As shown in the section view, there is an ample oil reservoir in the base, from which oil is drawn up by the rotation of the shaft through a series

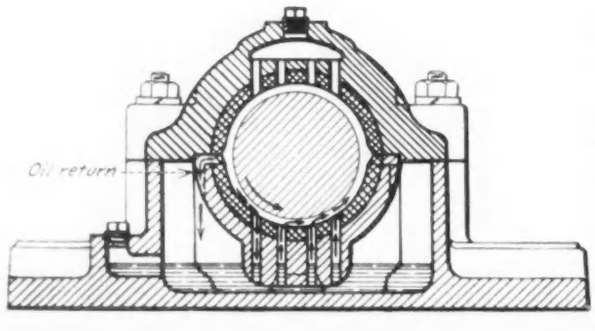
Robins-Jones Pillow-Block Bearing

of ducts or passageways in the bearing metal, the oil thus being spread uniformly over the whole shaft. At the parting of the cap and base, there are slots from which scavenger holes return excess oil back into the reservoir. Grooves near each end of the bearing prevent leakage and lead the oil that works out to the ends back into the reservoir.

The automatic lubrication system is not affected by the rotation of the shaft. The range of speeds to which this bearing is adaptable is from 1 to 5,000 r.p.m. It may be applied to vertical as well as horizontal shafts and the load or pressure on the bearing may be from any direction since the cap has a similar reservoir and ducts, functioning just as the lower part of the bearing functions.

With the cap removed, the lower liner can be removed by rotating it around the shaft, thus making it unnecessary to lift the shaft out of the bearing. The base of the bearing is flat underneath rather than recessed, to provide better distribution of the weight. Base and cap are machined where they come together, and the ends are faced. The removable base liner rests in a finished saddle designed to resist forces resulting from the holding down bolts when the supporting surface is not true.

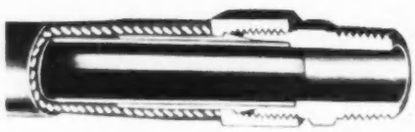
The bearings are available as separate pillow blocks or they may be obtained specially designed as a built-in unit of the machine. It is stated by the manufacturer that the price of these bearings is considerably less than those of equivalent ball or roller bearings.



Cross-section of Robins-Jones Bearing, showing the oil ducts from the reservoir

Sky Specialties Rubber-Covered Metal Tubing

Rubber-covered metal tubing for gasoline and oil lines of aircraft has been placed on the market by the Sky Specialties Corporation, Detroit, Mich. This tubing is designed to minimize forced landings through broken oil or feed lines. It is made of either aluminum or copper tubing, over which is a vulcanized fabric rubber tubing that is impervious to

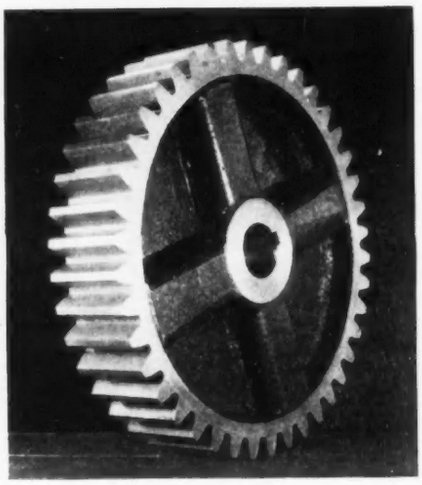


gasoline and oil. Should the metal tubing break, the vulcanized fabric rubber tubing will permit flight.

The special connection illustrated consists of a sleeve with a tapered end and an internally threaded sleeve, both of which are assembled on the tubing before vulcanizing the rubber in place. The inner sleeve with the tapered end is slipped back over the metal tubing until about 1 in. of tubing projects beyond the end. This sleeve carries the outer threaded unit. When the connecting nipple is screwed in, the tapered end of the inner sleeve acts as a wedge.

"Philweld" Welded Steel Gears

Welded steel gears ranging in diameter from 15 to 168 in. are now being manufactured by the Philadelphia Gear Works, Erie Ave. and G St., Philadelphia, Pa. These gears are especially adapted to heavy duty service. They have about 50 per cent greater tensile strength than cast gears, weigh 10 per cent less, and give longer service life. The design is such that they produce a good appearance,



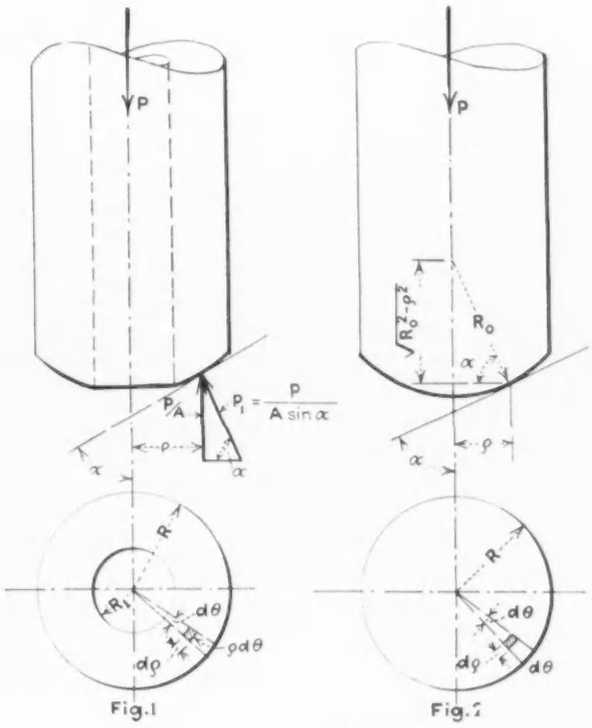
"Philweld" Welded Steel Gear, having the rim, center plate, and channel-shaped arms fabricated from steel plate and the hub from forged bar

all smooth welded beads being so located as to be unnoticeable. So much extra strength is embodied in this fabricated design that the only possibility of breakage is that of the teeth.

Rolled S.A.E. 1040 steel plate is used for the rim, center plate, and arms. The center plate and rim are cut from plate by means of a gas torch. The arms are formed into channels from the same plate, cut to shape and welded to the center plate and the rim. The hub is cut from forged steel bar and drilled to receive the shaft. After all welding is done, the fabricated gear is normalized to remove all strains and the teeth in the rim are cut. As a result, an entirely homogeneous and balanced gear is obtained, and the dense nonporous character of the steel assures long wear on metal-to-metal contact.

"Philweld" gears are available in spur, helical, herringbone, bevel, spiral, and Sykes continuous herringbone types. They are also available in the company's line of heavy-duty speed-reducer units.

Chart for Thrust Bearing Friction Moment Determinations



Equilibrium of forces on cylindrical shafts sustaining axial loads

THE general case of a hollow cylindrical shaft sustaining an axial load on its convex end face, is shown in Fig. 1. Using this figure, the general equation for the calculation of the moment of friction on a thrust bearing surface can be derived for any values of the variables involved. Let the total axial load be P, the inside radius R_1, and the outside radius R. On the end view is shown an infinitesimal area dA of width $\rho d\theta$ and length $d\rho$. If P_1 represents the unit pressure normal to the surface at this selected point, then the total pressure on that area will be $P_1\ \rho d\theta d\rho$.

Pressure is normal to the surface. The summation of the horizontal components of all the elementary pressures must be equal to zero while the summation of the vertical components must be equal to the total axial load P. Let it be assumed that the thrust pressure is distributed uniformly over the projected area. The unit pressure on the projected area will then be P/A, the corresponding unit pressure P_1 on the curved area being $P/A \sin \alpha$ where α is the angle as shown in Fig. 1. Multiplying each unit pressure, $P/A \sin \alpha$ by the unit area $\rho d\theta d\rho$ and by f, the coefficient of friction, gives the frictional force resisting the rotation. Multiplying again by the corresponding radius distance ρ from the differential area to the center of rotation, gives the frictional resisting moment equal to:

$$\text{Differential Friction Moment} = \frac{P}{A \sin \alpha} \rho\, d\theta\, d\rho\, f\, \rho$$

$$= \frac{P f}{A \sin \alpha} \rho^2\, d\rho\, d\theta$$

Summation of these differential moments between the limits of $\theta = 0$ to $\theta = 2\pi$ and $\rho = R_1$ *to* $\rho = R$, gives the total friction moment. For any given problem, f, P, and A are constants. Hence

$$M_f = f \frac{P}{A} \int_0^{2\pi} \int_{R_1}^{R} \frac{\rho^2\, d\rho\, d\theta}{\sin \alpha} \qquad (1)$$

A common condition is a solid shaft with the end a plane perpendicular to the axis of the shaft. Here $R_1 = 0$, $\alpha = 90°$ or $\sin \alpha = 1$. After making the substitution in the general equation and integrating we get:

For a solid shaft with plain end face perpendicular to the axis,

$$M_f = \frac{2 P f R}{3} \qquad (2)$$

Similarly for a hollow shaft with plain end face perpendicular to the axis,

$$M_f = \frac{2 P f (R^3 - R_1^3)}{3 (R^2 - R_1^2)} \qquad (3)$$

For a conical pivot of cone angle constant, $\sin \alpha$ is a constant, and

$$M_f = \frac{2 P f R}{3 \sin \alpha} \qquad (4)$$

If the bearing surface be the segment of a sphere, as shown in Fig. 2, $\sin \alpha$ must be put in terms of the other variables that can be integrated. Referring to Fig. 2,

$$\sin \alpha = \sqrt{\frac{R_0^2 - \rho^2}{R_0^2}}$$

Substituting in the general equation and integrating, we get:

For a solid shaft with the end a segment of a sphere of radius R_0,

$$M_f = \frac{P f R_0}{R^2} \left[R_0^2 \sin^{-1} \frac{R}{R_0} - R \sqrt{R_0^2 - R^2} \right] \qquad (5)$$

For a hemispherical seat, $R = R_0$, and,

$$M_f = \frac{\pi P f R}{2} \qquad (6)$$

Contributed by H. M. Brayton, Mechanical Engineer

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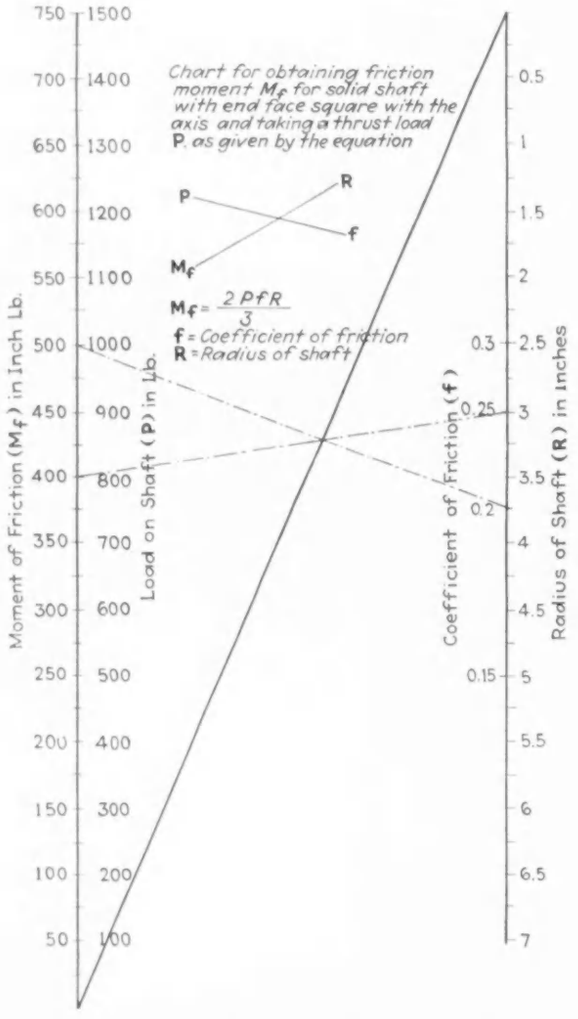
Chart for Thrust Bearing Friction Moment Determinations



For the rapid calculation of frictional resisting moments, a chart such as shown by the illustration on this page for a solid shaft with end face square with the axis may be constructed. In using this chart, it is merely necessary to connect the given values of P and f as found on their respective scales by a straight line. Where this line, shown dotted in the chart, crosses the diagonal, join this point with the given value of R as found on the scale, and extend to the left-hand scale where will be found the desired friction moment. Knowing the friction moment and the speed of the shaft, the power lost in friction can be calculated.

In constructing a chart such as shown, two parallel lines and a diagonal cutting them at any convenient angle are drawn. The scales are laid out on the parallel lines beginning at the point of intersection with the diagonal. The formula to be plotted is,

$$M_f = \frac{2PfR}{3}$$

The equations of the four scales in general terms may be written as follows:

$$X = m_1 M_f$$
$$Y = m_2 R$$
$$Z = m_3 \times 2P$$
$$T = m_4 \frac{3}{f}$$

In the above, m_1, m_2, m_3, and m_4 are known as the modulae of the scales and may be given any value within the scale limitations. The value assigned to them will be such that when multiplied with the maximum value assigned to the variable will not produce too long a scale. Actually but three of these modulae can be assigned values as the fourth one must be such that the following relation holds:

$$\frac{m_1}{m_2} = \frac{m_3}{m_4}$$

Thus for the chart illustrated, the following values were assigned for each of the modulae:

$$m_1 = 0.02$$
$$m_2 = 2$$
$$m_3 = 0.005$$
$$m_4 = \frac{m_2 m_3}{m_1} = \frac{2 \times 0.005}{0.02} = 0.5$$

The four scales then become

$$X = 0.02 M_f$$
$$Y = 2R$$
$$Z = 0.005 \times 2P = 0.01P$$
$$T = 0.5 \times \frac{3}{f} = \frac{1.5}{f}$$

To plot these scales one merely assigns different values to each variable and solves. This is then the distance measured along the parallel line from the point of intersection with the diagonal to a point which is to be marked with the assigned value of the variable. For example, suppose we take the equation for the M_f scale which is,

$$X = 0.02 M_f$$

For a value of M_f equal to 50, we get that $X = 0.02 \times 50 = 1$. This means that the value of 50 on the moment scale is at a distance 1 in. above the point where the line is cut by the diagonal.

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